

1. About 500 gallons of chrome-containing paint sludge in Building 47, November, 1988.
2. About 12,000 gallons of zinc and chrome-containing process waste water in the NW corner of Building 53. A minimum of 7,000 was vacuumed-up in March, 1989.
3. Overfill of TCA storage tank (quantity unspecified), June, 1989.
4. Chromium sludge discovered during demolition of Maxwell Complex in old, abandoned sewer leading to an oil-water separator east of Building 40B, November, 1990.
5. About 30 gallons of CFC-113 in empty drum storage area, November, 1990.
6. About 35 gallons of untreated waste water containing flux rinse water near Building 50, March, 1991.
7. About 150 gallons of water/sulfuric acid solution in Building 50 parts washer, January, 1992.
8. Unspecified quantity of TCA from storage tank next to Building 53, May, 1992.
9. Unspecified quantity of Alcoat 300B, conversion coating accelerator, in containment area of Building 40A, February, 1992.

3.2 Off-Site Potential Sources

A survey of potential off-site sources of regulated compounds was conducted using zip code areas. A survey of the EPA and Ohio EPA databases (1991) was previously completed using the Zip Code of 45414. Identified sites were listed in Appendix A of the Burlington Site Assessment report and were depicted in Plate 1 of that report. These records were again reviewed and it was determined that the following facilities were within an about two mile radius or less to the plant.

These include, according to our search:

EPA Sites

- Gem City Chemicals, Inc.

CERCLIS Sites

- Montgomery County North Incineration

Ohio EPA did not have any records for American Lubricants Company, Montgomery County North Incinerator, Ris Paper Company, Gem City Stamping, Inc., and Brainerd Industries. Hohman Plating and Manufacturing and Angell Manufacturing Company information consisted of contingency plans, RCRA inspections and records of personnel right-to-know training. There have been no site investigations or remediation projects at any of these sites according to State of Ohio EPA records. The most extensive records obtained for remediation activities were for Gem City Chemicals Inc. and DAP, Inc.

DAP Inc. is located at 220 Janney Road in Dayton, Ohio. DAP Inc. is involved primarily in the manufacture of adhesive products. A 1988 site assessment report was prepared by Applied Geotechnology, Inc. The facility began operation in the early 1960s and has been involved in the manufacture of caulking, glazing, and adhesive compounds. The property covers about 6 acres and includes a manufacturing and warehouse building, several underground storage tanks, outside storage, parking lots, and undeveloped open areas.

Based on historic information there are several in-plant tanks used to store materials including methyl ethyl ketone (MEK), methylene chloride, TCA, latex, paragon-500, sodium silicate, NF Brush (2000), and Tergitol NP-10. Materials stored in the USTs include: various halogenated and non-halogenated volatile organic solvents, toluene/lactol blend, MEK, mineral spirits, naphtha, acetone, negaloid toluene, and TCA.

Soil samples have been taken at various locations on the property including the underground storage tank area and the undeveloped area north of the manufacturing building. The samples were tested for TPH and VOCs. About one-third of the samples contained TPH concentrations above detection limits, 9 samples contained greater than 50 mg/kg and 1 sample contained greater than 100 mg/kg. Approximately one-fourth of the samples had detectable concentrations of the

Target Compound List (TCL) VOCs. The most frequently detected VOCs was TCA, with 24 samples above detection limits (averaging from 0.120 - 5.19 mg/kg). Other VOCs detected included carbon tetrachloride, 1,1-dichloroethane, 1,2-dichloroethane, and toluene.

Gem City Chemicals, Inc. is located at 1287 Air City Avenue in Dayton, Ohio. Gem City Chemicals operations are primarily blending and distribution of chemicals. The plant occupies about 7 acres and is located about 200 yards east of the DTPP property boundaries. The B&O Railroad line separates the two sites. According to the July, 1993 revision of the site assessment report prepared for Gem City Chemicals, Inc. by Q-Source Environmental Services, Inc. and on file with the State of Ohio EPA, the plant has operated at the site since 1969.

Typical operations include the purchases of various chemical products in truck load quantities, the repackaging of chemicals into smaller containers, drums and tote tanks, and the resale of these smaller quantities of chemicals to industrial customers. Both liquid and solid chemicals are handled and include: acids, solvents (including but not limited to toluene, xylene, freons, TCA, ethyl acetate, MEK, TCE, acetone, and naphtha), and other miscellaneous chemicals.

Site assessments were conducted in 1987 and 1988 at Gem City. Initial sampling included soil sampling at 12 locations in June, 1987, a soil gas survey at 40 locations in July, 1988, and groundwater sampling from 10 monitoring wells constructed in 1988. Soil sample tests at several locations detected 10 organic chemicals including: methylene chloride, PCE, TCE, TCA, methyl alcohol, isopropyl alcohol, acetone, toluene, xylene, and MEK. Soil gas survey results detected TCE, PCE, and TCA at a number of locations including samples taken near the B&O Railroad tracks to which the DTPP is contiguous. Groundwater monitoring well analysis was completed on a regular basis from 1988 - 1993 and the following has been detected: acetone, benzene, chloroform, 1,1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene,

trans 1,2-dichloroethene, ethylbenzene, hexachlorobutane, PCE, toluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, TCA, TCE, and vinyl chloride.

Gem City Chemicals remediation project is ongoing and includes an air stripper system, groundwater recovery wells which were installed in 1987, and a soil vapor extraction system consisting of five soil vapor extraction wells. The soil vapor extraction system was shut down in 1991 and restarted for a brief period of time in 1992. Since no significant concentration of VOCs (≤ 5 ppm) were detected, the vacuum extraction wells were abandoned with removal of the blowers and filling the wells with grout.

3.3 DTPP Site Summary

Soils:

The results of the investigation by Burlington indicated the soils were impacted by organics. These include primarily TCE, TCA, PCE and some heavy metal contamination (chromium and lead). Based on soil gas results, the areas which may have been impacted by plant operations or other sources include:

- Building 40B in the area which contained the former CFC-113 degreaser station.
- South side of Building 53 which contains the TCA storage tanks.
- Buildings 40A and 40B which contained former parts degreasers.
- West and southwest section of the former Maxwell Complex or present Building 59.
- Storage areas located east of Building 50.

Groundwater:

To summarize groundwater quality, there are 3 process cooling water wells on-site. Well 1, located in Building 40, has been abandoned. Well 2 is in the boiler house and is about 80 feet deep. Well 3 is east of Building 50 and is about 135 feet deep.

The wells were sampled by the State and DTPP several times between November 1989 and July 1990. The analytical results indicate that Well 2 contains the following:

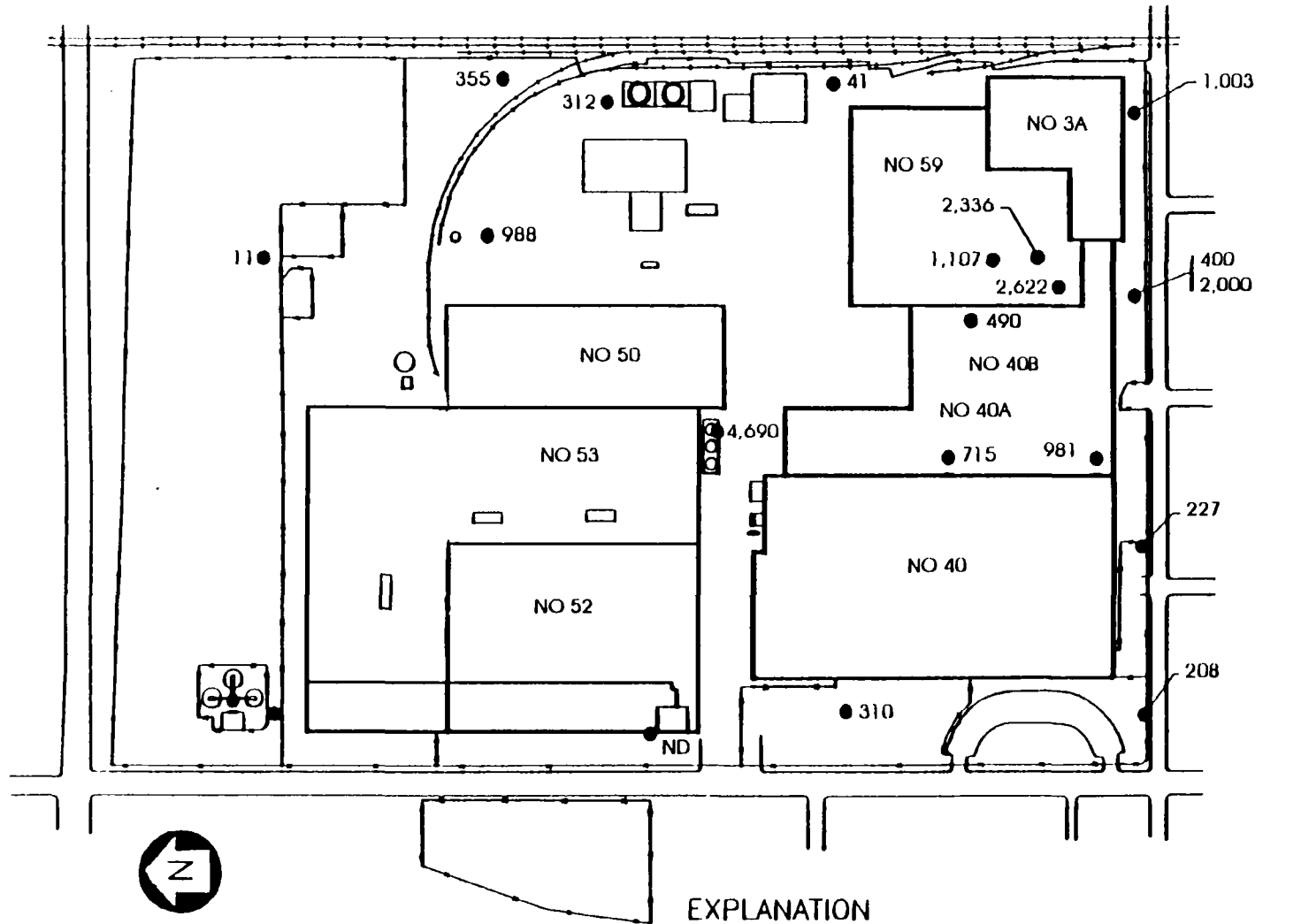
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Trans-1,2-Dichloroethene
- Tetrachloroethene
- 1,1,1-Trichloroethane
- Trichloroethene
- Vinyl Chloride

Well 2 contained no regulated compounds. Additional groundwater samples were taken at the time soil gas was completed. The samples were drawn through the soil gas probe and should not be considered representative samples. Figure 8 shows total VOCs found at that time. The results indicated that groundwater may have been impacted near Buildings 40A, 40B, 59, and 53. More definitive groundwater studies should be completed.

In summary, past plant activities may have impacted the soil and groundwater at the site. Due to the age of the plant and past plant uses (especially the Maxwell Complex, circa 1907), the variety of products manufactured over the years, much of the former history at the plant is not known. As stated in Section 2, most of the chlorinated solvent degreasing operations have been removed and/or replaced. The present and last TCA degreaser in Building 40A is scheduled for replacement with an aqueous washer in early 1994. The associated storage tanks outside Building 53 are also scheduled for removal in 1994. The CFC-113 degreaser in Building 40A is scheduled for replacement with a vacuum de-oiler with removal in mid-1994. The small CFC-113 engineering lab degreaser will be replaced as soon as an acceptable alternative is found, most probably in mid-1994.

FIGURE 8

TOTAL VOCs IN GROUNDWATER DAYTON THERMAL PRODUCTS PLANT



EXPLANATION

- 310 APPROXIMATE RECON™ PROBE HOLE LOCATION
- 310 TOTAL VOC CONCENTRATION IN GROUNDWATER (ug/L)
- ND NOT DETECTED

Prior to considering further remediation, additional investigations must be performed to more fully characterize the site. In addition, it is possible that DTPP may have been impacted by two nearby facilities. They are DAP and Gem City Chemicals, Inc. A better understanding of the DTPP site will be possible after groundwater quality and direction are determined.

SECTION 4.0 - GEOLOGIC & HYDROGEOLOGIC CHARACTERIZATION

4.1 Regional Geomorphology

The Dayton area is located in the central lowland and physiographic province which is primarily drained by the Miami River and its tributaries (USGS-1966). The Dayton plant is located on a flat topped terrace which is an erosional remnant from the outwash of the Mad River (see Figure 9). This glacial outwash gravel unit stretches northward to Urbana and southward to the Miami River. The surface materials of these types of outwashes consist of coarse sand and gravel, although other sediment types may be present. In some areas of the Mad River outwash, windblow losses which contains silt has been noted. The terrace is bordered on the north, west, and south by the flood plains of the Miami and Mad Rivers. Flood plain sediments are about 20 feet thick. The top of the moraine is present north-east of the site in Mad River Township. The moraine was mapped as a thin to thick layer of till overlaying sand and gravel by Goldthwait (Norris, Cross, Goldthwait, 1948) and by Forsyth (Norris & Spiker, 1966).

4.2 Regional Stratigraphic Units

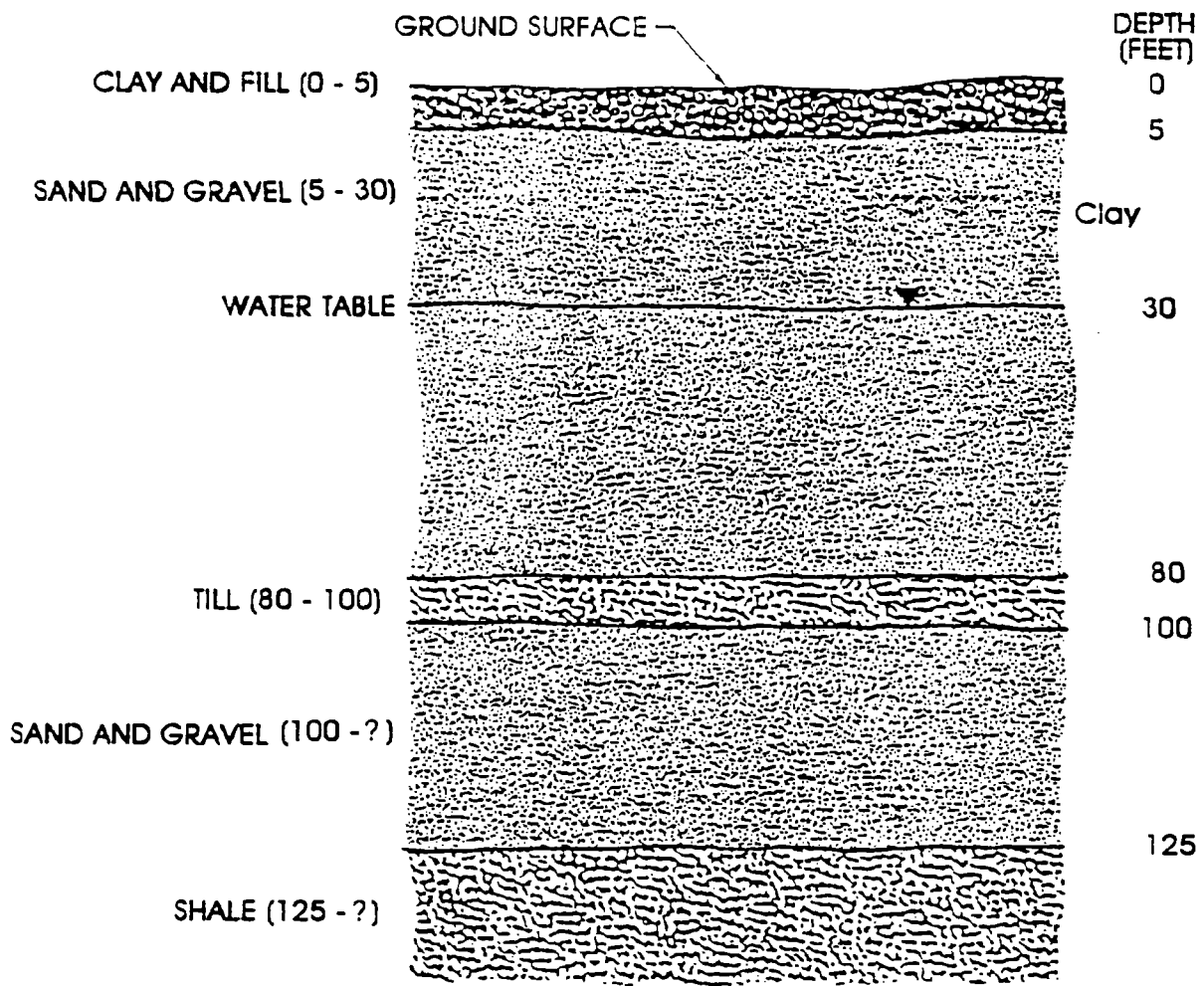
There have been regional studies completed by Norris & Spiker (1966) which confirm that the uppermost unconsolidated unit consists of an outwash deposit up to 80 feet thick. The outwash deposit contains primarily sand and gravel. Discontinuous till lenses have been encountered in some wells in the vicinity of the Dayton site. Published studies by Norris & Spiker (1966) indicate that the till layer may be discontinuous on a regional scale. These reports suggest that at some locations the till is a thick massive unit while at other locations it has been logged as stratified with sand and gravel. The location of this till layer becomes important when attempting to determine the direction and rate of regional groundwater flow. A continuous layer of till was noted in the geologic cross-section of Gem City Chemicals which borders DTPP along Air street. The layer was observed from 80 - 100 feet below grade.

A second aquifer unit was noted under the till in regional studies. The till layer is composed of fine to medium sand, sand and gravel and fine to coarse gravel (NEARBI Site Investigation). Gem City Chemicals, Inc. has drilled a total of twenty-four test borings throughout their facility. Boring logs are contained in the Site Assessment Report prepared by Q-Source Environmental Services, Inc. dated July 28, 1993. The logs suggest that the surface material at the site is about 80 - 90 feet thick. Surface materials consist of coarse to fine sand and gravel. Below this surface material is a continuous layer of dense till consisting primarily of silt. A thin clay or silt layer was also encountered near the surface at a depth of about 15 feet. Based on these borings for Gem City Chemicals, the following was noted:

- The surface materials consist of a thin disturbed layer of fine-grained loess, coal fragments, and fill material.
- The next layer consists of a sand and gravel deposit. The material contains medium to coarse sand and small pebbles with interstitial fine sands and silt. The thickness of this layer is about 20 feet.
- Another layer of fine sand or silt was encountered at 20 feet. This silty-clay layer was observed in the test borings and in monitoring wells known as the MW-5 cluster and RW-1. It varies in thickness from 6 inches to 2 feet.
- The next well defined unit from about 20 feet to the bottom of the uppermost aquifer consists of outwash deposit material. This is composed of interbedded coarse sand to granules with traces of pebbles and silt.
- At a depth of 82 feet a dense layer of silt was encountered (Boring P-4). This unit consists of dark gray silt, with fine to coarse sand and trace pebbles.

The information prepared for Gem City is in agreement with other regional reports on the stratigraphy of the area. (See Figure 10 for conceptual stratigraphy for DTPP.)

FIGURE 10
CONCEPTUAL STRATIGRAPHY
DAYTON THERMAL PRODUCTS PLANT

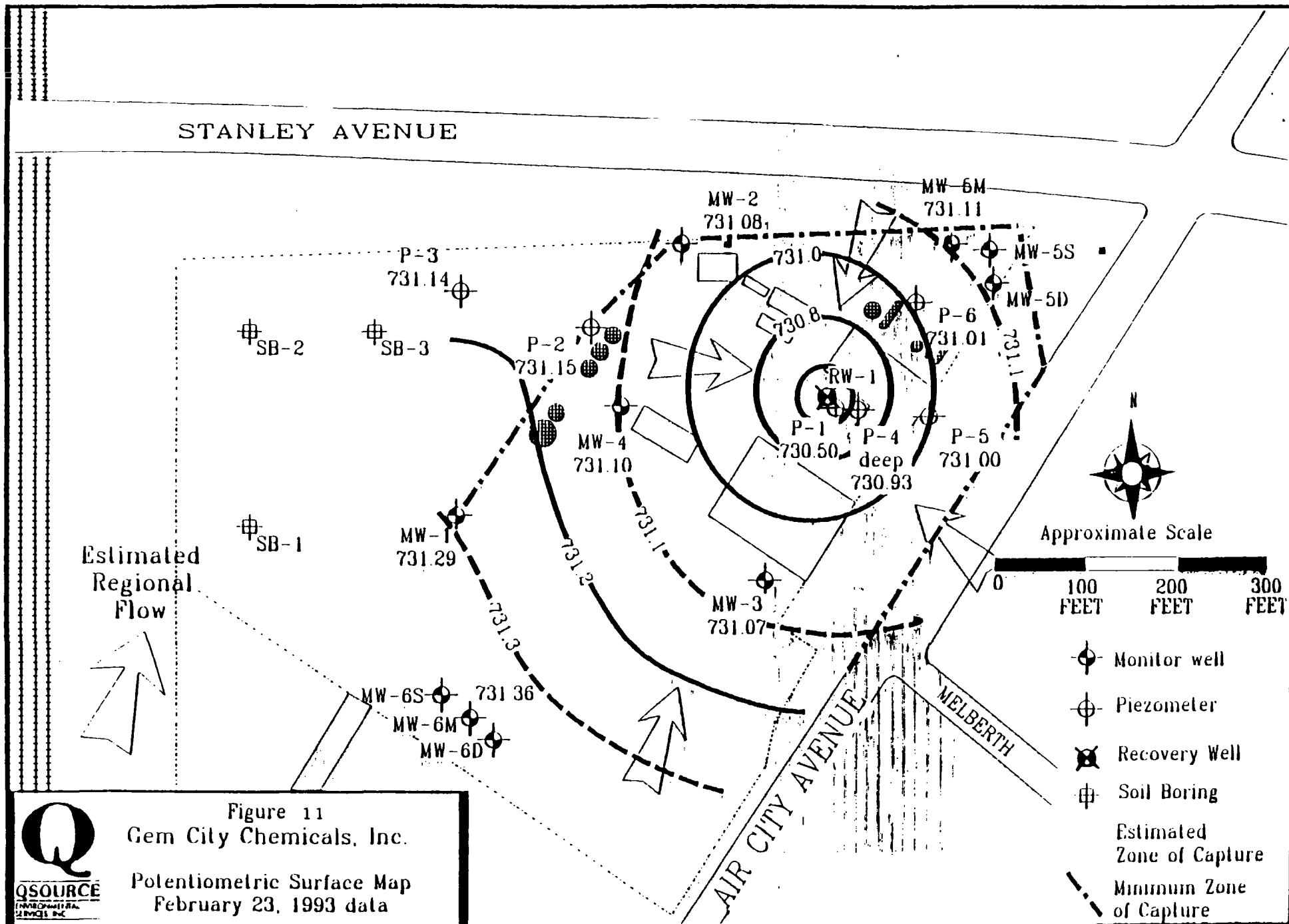


4.3 Site Hydrology

Several reports were evaluated to determine the regional as well as local direction of groundwater flow. Reports by Norris & Spiker and CH₂M Hill established that regional flow was towards the southwest, parallel to the Miami South Wellfield.

According to other published reports, flow direction has changed to the north following the installation of the City of Dayton's Miami South Well Field in the early 1960's. The groundwater flow divide originally located north of Gem City Chemical has shifted to the south. This has changed groundwater flow at the plant to the north-east. The gradient across Gem City Chemical is flat and any changes or alterations to the pumping of the Miami South Well Field will likely alter the flow of groundwater. Also, another factor which may shift groundwater flow direction is the amount of recharge to the aquifer. Measurements taken at Gem City Chemical indicate that the elevation of the groundwater to the surface has varied by about 12 feet reaching a high of 730 MSL in 1991 and a low of slightly over 718 feet in February, 1992. This is a result of a normal water cycle in which there is a rising groundwater table during the winter and spring and a falling groundwater table during the summer and fall. A review of the potentiometric surface measurements however indicated that at the Gem City Chemical site, variations in recharge do not appear to affect the general direction of groundwater flow. It has been shown, however, to affect the overall elevation of the groundwater table and the associated saturated thickness of the aquifer.

At the Gem City Chemical site one of the most important factors affecting groundwater movement is the presence of a recovery well system in the center of the site which pumps at approximately 300 gallons per minute (gpm). This recovery well has created a cone of depression at the Gem City Chemical site (see Figure 11).



4.4 Aquifer Characteristics

The hydraulic conductivity of the shallow aquifer is approximately 200 feet per day. Using an estimated saturated thickness of the shallow aquifer of 30 to 80 feet, the transmissivity of the aquifer is approximately 15,00 to 40,000 square feet per day (Q-Source -1989).

Studies completed by Dames & Moore in 1991 for the DAP site which is located about 4 miles north of this site, included an aquifer recovery test which monitored drawdown in the monitoring wells and piezometers surrounding the pumping well. Transmissivity values were calculated from the recovery results and were in the range of 249,000 gallons per day per foot to 747,000 gallons per day per foot. The transmissivity appears to generally be lowest in the shallow part of the aquifer and it increases with depth.

The lithology of the deep aquifer is very similar to the shallow aquifer. Based on reports prepared for Gem City Chemicals, it appears to be irregular. The saturated thickness of the deep aquifer is approximately 60 feet thick.

The deep aquifer contains a significant amount of silt which has impacted its hydraulic conductivity. Groundwater in the deep aquifer is under semi-confined conditions. Hydraulic conductivity values for the deep aquifer range from 140 - 200 feet per day. Reported transmissivity ranges from 1,200 - 12,000 square feet per day. A storage coefficient of 0.001 is within the expected range for a confined aquifer.

Values for the aquifer parameters developed by CH₂M Hill in 1972 for the development of the Miami South Well Field were:

Upper Aquifer

Hydraulic Conductivity - 0.003 ft/sec (260 ft/day, 2021 GPD/ft²)

Storativity - 0.2 ft/ft

Till Layers

Hydraulic Conductivity - 0.44×10^{-6} ft/sec (0.04 ft/day, 0.3 GPD/ft²)

Storativity - 0 ft/ft

Lower Aquifer

Hydraulic Conductivity - 0.001 ft/sec (87 ft/day, 710 GPD/ft²)

Storativity - 0.00001 ft/ft

This model assumed a 50 foot thick saturated zone in the upper aquifer, and variable thicknesses for the till and lower aquifer. The transmissivity values were not calculated directly. All values were calculated assuming that each of the layers within the model are homogeneous and isotropic. Due to the directions of flow that are calculated from this model, the calculated hydraulic conductivities are likely to reflect the horizontal conductivity in the "upper" and "lower" aquifers, and the vertical conductivity through the till. Considerable local variability from these values is likely across the region.

During the pump test conducted at Gem City Chemicals, Inc. on February 21, 1990, the recovery well was pumped at a rate of 340 GPM and the water level in the piezometer installed 3.5 feet away from the pumping well was monitored. The drawdown was 0.75 feet after 450 minutes of pumping. This gives a value for transmissivity of 52,900 square feet per day or 395,000 gallons per day per feet and conductivity of 0.226 centimeters per second (755 ft/day). This value is about three times the average value calculated from the model studies. The effective porosity of the silty sands and gravels found in the Dayton area is estimated to be 20 percent. The storativity is estimated to be 0.10 to 0.20, based on the estimated effective porosity.

Based on these values, the pre-pumping groundwater flow velocity is estimated to be about 1.2 feet per day. The current flow velocity in the area surrounding the pumping well is estimated to be 6.4 feet per day. The potentiometric surface elevations have been measured in the two well clusters located at the northeast and southwestern limits of Gem City Chemicals, Inc. The levels measured in the three wells in each cluster are similar, which indicated that the groundwater flow is nearly level at both locations.

Due to the presence of the till layer separating the valley fill deposits into "upper" and "lower" aquifer systems, the direction of groundwater flow was evaluated separately at Gem City Chemicals for each of the two layers. As described previously, a low-permeability till layer is present beneath Gem City Chemicals, Inc. and for at least one-half mile surrounding the site. This till layer effectively isolates the uppermost, unconfined aquifer at Gem City Chemicals, Inc. from any deeper, confined aquifers that may be present.

Ground-water flow directions in the lower aquifer have changed considerably during the past thirty years, due to changes in water usage in the surrounding areas. Potentiometric maps compiled by Norris & Spiker (1966) for 1959 and 1960 (prior to the time when the Miami South Wellfield began operations) show groundwater flow to the southwest, towards a wide cone of depression developed beneath the central business district of Dayton, and also towards industrial facility water supply wells to the southwest. A major cone of depression had developed beneath the Miami South Wellfield following the beginning of production of water from the wellfield, in the early 1960's. Maps compiled by CH₂M Hill for 1972 and for 1986 show this cone of depression. The location of Gem City Chemicals, Inc. appears to be on or near a divide between these two cones of depression, and the direction of groundwater flow at the site could be either to the north or to the south, or it could fluctuate depending on recharge variations and variability in the pumping rates at the city's wellfield.

4.5 Local Groundwater Use

The most prominent local user of groundwater is the Miami River Well Field owned by the City of Dayton. It is located north of the Dayton plant across the Great Miami River. It contains 22 production wells (Geotrans, 1986).

Other water supply wells in the vicinity of the plant site are shown in Figure 12. Available driller logs are contained in Attachment 1. These logs indicate that most of the local wells are located at depths of 30 to 65 feet.

In August of 1988, the City of Dayton adapted a Well Field Protection Program to protect its well field and drinking water supplies. The southern limit of the Miami Well Field Protection Overlay District is Stanley Avenue. Well yields for wells within the area as published in Norris & Spiker (1966) range from 20 gallons per minute (No. 209) to a maximum of 1,000 gallons per minute (No. 212). A test well in the Miami South Well Field pumped at a rate of 2,283 gallons per minute. The City's Mad River Well Field is approximately two miles to the east of the site and does not receive any recharge from this area as reported by Q-Source for Gem City. Figure 13 indicates the extent of the wellfield protection district.

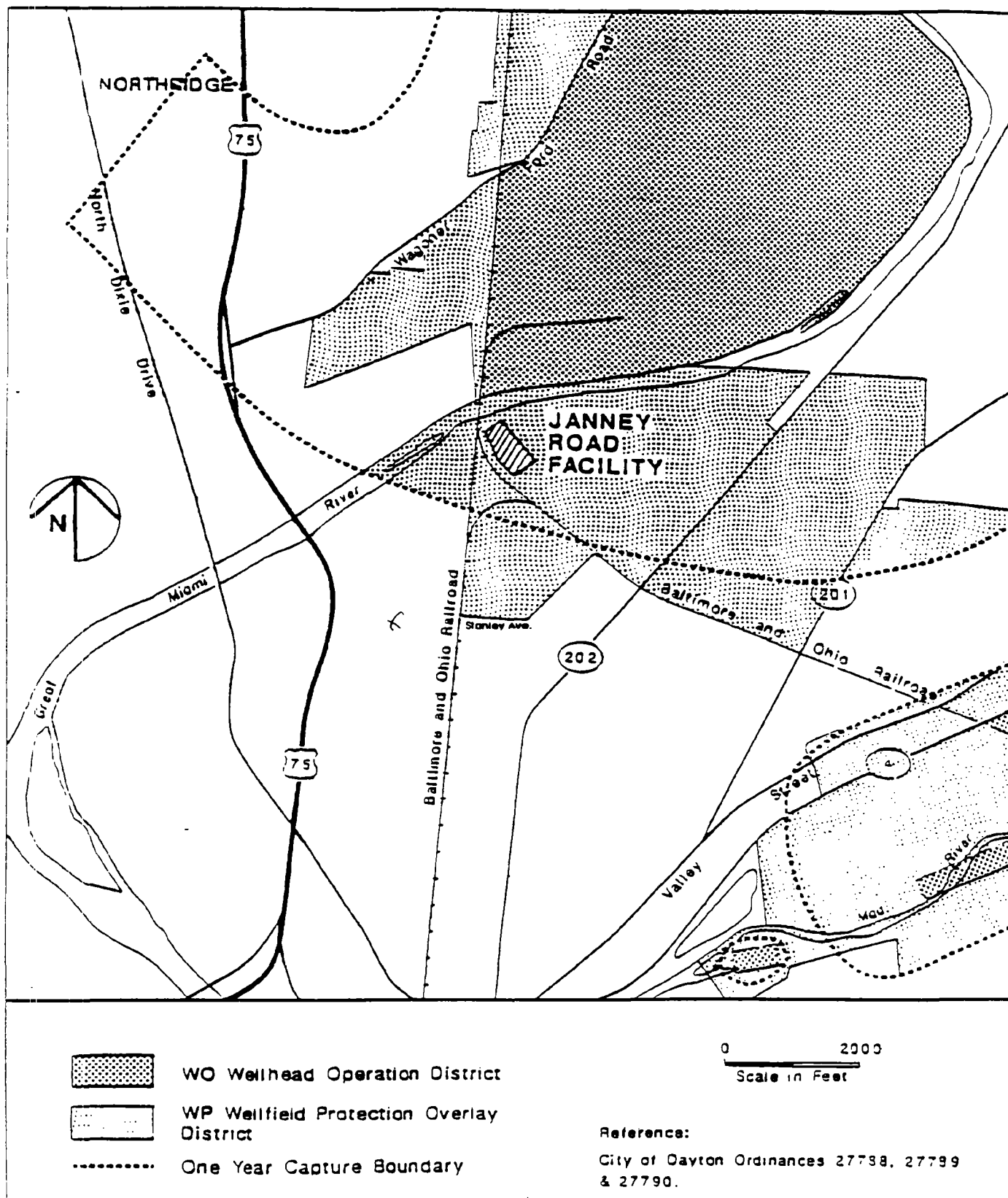


Q

CDNR

QSOURCE

**ENVIRONMENTAL
SERVICES, INC.**



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

GROUNDWATER PROTECTION DISTRICTS

DAP Inc.
Janney Road Facility

FIGURE

13

SECTION 5.0 - REMEDIATION OBJECTIVES

5.1 Ohio EPA Policy

The Ohio Environmental Protection Agency Division of Emergency and Remedial Response (DERR) has developed guidance for hazardous waste site investigations and remediation programs. Ohio EPA evaluates every site independently and will not provide generic clean-up guidance or criteria. The policy was originally developed for unregulated hazardous waste sites but is used at Ohio EPA in the Remedial Response Program.

The process begins with determination of site contamination. A site is considered to be hazardous if a contaminant is detected as defined under Ohio Revised Code (ORC) 3734.02 and the contaminants are present on-site at concentrations significantly above background or the contaminants are present on-site and are not detected in representative background samples.

Once it has been determined that contamination exists, it must be determined if contamination poses a threat to public health or the environment. Ohio EPA has not developed specific action levels for chemical contaminants. Instead, a human health risk assessment must be performed to evaluate health effects caused by site specific contamination.

After site contamination has been characterized and risks posed by the contamination established, remedial alternatives can then be developed and evaluated. The criteria that Ohio EPA follows is that the alternatives must consider the following:

1. Overall protection of human health and the environment;
2. Compliance with applicable or relevant and appropriate standards and/or criteria;
3. Long term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume through treatment;
5. Short term effectiveness;

6. Implementability;
7. Cost;
8. Community acceptance.

Alternatives should establish remediation goals that meet the criteria outlined. Based on these preliminary findings, the risk assessment should focus on groundwater quality issues since the site is near the North Miami drinking water aquifer. The selected remedy must comply with all known Federal and State applicable or relevant and appropriate standards and/or criteria (ARARs). The following section discusses ARARs and their significance.

5.2 ARARs

In the evaluation of potentially applicable technologies to remediate DTPP, various technologies must be evaluated based on implementability and cost effectiveness. Before treatment technologies can be selected, however, the applicable or relevant and appropriate requirements (ARARs) must be reviewed. The ARARs that must be reviewed include the following:

- Any applicable or relevant and appropriate standards, requirement, criteria, or limitation under Federal law.
- Any promulgated applicable or relevant and appropriate standard, requirement or limitation under State law that is more stringent than the Federal requirement.

"Applicable" requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal/State environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or location. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be applicable.

"Relevant and appropriate" requirements are those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, or location, do address problems or situations sufficiently similar to those encountered that their use is well-suited to the particular site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be relevant and appropriate.

Additional information that does not meet the definition of potential ARARs may also be considered in determining the necessary level of cleanup for protection of human health or the environment. This "other information to be considered" (TBCs) includes criteria, advisories, or guidance developed by EPA, other Federal agencies, or States to assist in the determination of, for example, health-based levels for a particular contaminant for which there are no ARARs, or the appropriate method for conducting an action. Included in this category are health effects, information with a high degree of credibility, and technical information on how to perform or evaluate site investigations or remedial actions, and policy.

ARARs are grouped into three broad categories. These categories are as follows:

- *Chemical Specific* - These are health or risk based numbers that guide site cleanup and they may be based on actual concentration levels.
- *Location Specific* - This would include requirements for site sensitive features such as wetlands, well head protection areas, flood plains, etc.
- *Action Specific* - These ARARs pertain to monitoring requirements, manifesting requirements, etc.

Once the contaminants and the concentrations are known at the site, the following Federal and State contaminant specific ARARs should be reviewed:

EPA Primary and Secondary Drinking Water Regulations - These regulations were developed as part of Section 1412 of the Safe Drinking Water Regulations. It establishes enforceable maximum contaminant levels (MCLs) and non-enforceable maximum contaminant levels goals (MCLGs). EPA has also promulgated National Secondary Drinking Water Regulations which establish secondary MCLs which primarily affect the odor or appearance of drinking water.

EPA AWQC - This criteria is not legally enforceable but can be used by the states to protect human health from exposure to contaminants from ingestion of aquatic life. It also protects freshwater and aquatic life.

Other ARARs which need to be reviewed to determine if they are relevant to the remedial technologies chosen include:

- Clean Air Act - Three categories: NAAQS, National Emissions Standards for Hazardous Air Pollutants (NESHAPS), and New Source Performance Standards (NSPS) 40 CFR Part 60.
- Health Effects Assessment
- State of Ohio Surface Water Quality Standards
- RCRA Subtitle C - This may be applicable to materials generated as a by-product of treatment.
- Location Specific ARARs - Should be reviewed including criteria on the Miami Well Field area.
- State of Ohio Drinking Water Standards
- State of Ohio Air Pollution Regulations

Other ARARs which were identified but which are not relevant to this site included:

- DOT Rules for Hazardous Materials Transport - Only applies if waste is shipped off-site for analysis, treatment or ultimate disposal.
- RCRA "Land Ban" Disposal Restriction (40 CFR Part 268) - Restricts certain hazardous wastes from being placed or disposed on land unless certain treatment standards are met. Excavation and disposal of certain hazardous wastes will be subjected to LDRs.
- Standards for Owners or Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Part 264) - These standards only apply to TSDFs if certain types of remedial actions are completed on-site and it applies to off-site facilities that receive hazardous waste for treatment and/or disposal.
- Endangered Species Act of 1978 (16 USC 1531 - 40 CFR Part 502) - This act ensures that an endangered or threatened species is not affected adversely in its habitat. No federally listed endangered or threatened species are located on this site.
- CWA 1977 Section 404 - This section prohibits the discharge of fill material into jurisdictional wetlands without obtaining a permit from the U.S. Army Corps of Engineers. No discharge into wetlands is permitted if an alternative exists for the proposed project. Regulations, guidelines, and permit requirements have been established to prevent unregulated dredging, dumping, filling, and similar activities that would destroy these sensitive habitats.

SECTION 6.0- RECOMMENDATIONS

6.1 Overall Recommendations

After a thorough review of on-site and off-site data, it was determined that the following activities/tasks should be completed to fully characterize the site.

- Evaluate subsurface conditions and the vertical stratigraphy of the site. Include both the upper and lower aquifers. A sufficient number of borings should be completed to adequately determine if the first aquifer is a confining or semi-confining layer.
- Establish groundwater flow in the water table and lower aquifer. Local data obtained from Gem City Chemicals indicates that groundwater flow has been significantly affected by the pumping of the Greater Miami Wellfield. This should be confirmed.
- Several shallow (less than 50 feet) and deep (approximately 100 feet) boreholes should be completed to fully evaluate stratigraphy using split-spoon sampling. Selected boreholes should be completed as monitoring wells.
- Evaluate the groundwater quality of the two aquifers including priority pollutants. Conduct pump tests on selected wells to determine if any of the installed wells can later be converted to a groundwater recovery well system.
- Halogenated organic compounds were found during the site investigation of the Maxwell Complex and are characterized as DNAPLs or Dense Non-Aqueous Phase Liquids. The heavier-than-water compounds can sink in an aquifer system and migrate downslope as a separate, non-aqueous phase displacing water as they migrate. Residual DNAPL can remain within the vadose and saturated zones, trapped by surface tension within soil pore spaces. The compounds will typically continue to migrate vertically until they become deposited in pore spaces or until they reach a less permeable layer, such as a till or clay. If the impermeable layer is sufficiently sloped, DNAPLs may "pool" in depressions.

DNAPLs can migrate in directions other than the direction of groundwater flow.

DNAPLs in the vadose zone dissolve into the water and vaporize into soil gas.

Therefore, since the site may contain compounds which includes DNAPLs, the following should be evaluated at the site:

1. Determine DNAPL concentrations of compounds which may be as low as 1% saturation of a certain DNAPLs solubility.
 2. Determine the presence of dissolved phase chemicals upgradient.
 3. Confirm through analysis soil gas data which indicates "hot spots".
- Develop remedial alternatives which should include an evaluation of combinations of treatment technologies such as: soil vacuum extraction, groundwater pumping and treatment, stream injection, bioremediation, and soil flushing.
 - The nearby Gem City Chemicals, Inc. site has a recovery well system and an air stripper to recover DNAPLs. Studies at this site concluded that there was no separate phase caused by DNAPLs beneath Gem City Chemicals, Inc. The concentrations measured at the site and the solubility of the chlorinated compounds were compared. It appears that the concentrations found at Gem City are below maximum solubilities of these compounds which would indicate that the compounds are dissolved and are moving with the groundwater and not migrating as a separate phase. In addition, the concentrations of solvents found in the monitoring wells were highest at the shallow depths and are near non-detect at the bottom of the aquifer. It appears that the DNAPLs are traveling with the direction of groundwater flow which would be away from DTPP. In order to confirm this, wells should be installed near the property boundary between Gem City and DTPP.

The following section outlines the preparation of a plan to implement installation of monitoring wells and soil borings to characterize the site.

6.2 Field Sampling Plan (FSP) Outline

The primary purpose of the soil boring program is to characterize the site's geology and to obtain samples for geotechnical analysis. The FSP also provides the sampling rationale, procedures, and deliverables to be used in the implementation of field sampling activities. The FSP will include the following items:

- a) One or more maps depicting proposed sampling locations. A site survey map should also be completed which will be prepared at 1 inch equals 20 feet. Vertical control will be referenced to the National Geologic Vertical Datum (NGVD). Horizontal control will be referenced to the Ohio State Plane Coordinate System.
- b) A detailed description of all sampling, analysis, testing and monitoring to be performed including sampling methods, analytical and testing methods, and frequency of sampling and sampling locations.
- c) An analysis of Data Quality Objectives (DQOs) describing how the sampling, analysis, testing and monitoring will produce data useful for meeting the objectives of remediating the site.
- d) A schedule for performance of specific sampling and testing tasks.
- e) A description of geophysical investigations to better define subsurface conditions applicable to characterize the subsurface.

Other items to be addressed include:

- Inspection of the work;
- Daily documentation logging;
- As-built drawings;
- Health & Safety Plan, site specific;
- Coordination of activities.

All drilling activities will be completed using a 4¼" ID hollow stem auger with split-spoon sampling continuously at 2 foot intervals until the lower confining unit is reached. A geologic cross section will be prepared. All soil cuttings will be field screened for organic vapors.

Large diameter (3 inch) spilt-spoons will be used for the collection of samples for geotechnical laboratory tests. Blow counts will be recorded and standard penetration noted. Grain size analysis should be performed as required using ASTM 422. Moisture content using ASTM Method 2216 and Atterberg limit tests should be performed in conjunction with the grain-size analysis.

Quality Assurance Plan:

Where appropriate, analysis will be performed in accordance with EPA methods and procedures.

The following items should be included in each analytical report:

- Title Page;
- Table of Contents;
- QA Objectives;
- Sampling Procedures;
- Sample Custody;
- Calibration Procedures and Frequency;
- Analytical Procedures;
- Data Reduction, Validating and Reporting;
- Quality Assurance Reports.

After the borings have been logged and completed, several will be converted to monitoring wells with five foot stainless steel screens. Screen locations will be selected by the driller based on results of the boring program and groundwater sampling.

Attachment 1
Well Logs

WELL LOG AND DRILLING REPORT

ORIGINAL

OHIO WATER RESOURCES BOARD

Department of Public Works

553 E. Broad St., Columbus 15, Ohio

County Montgomery Township Harrison Section of Township 2619 Kachle
 or Lot Number
 Owner Lila Jones Address 2619 Kachle Ave
 Location of property North Ridge Dayton

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter 4 1/2" Length of casing 34' Pumping rate _____ G.P.M. Duration of test _____ hr.
 Type of screen _____ Length of screen _____ Drawdown _____ ft. Date _____
 Type of pump NORP Developed capacity _____
 Capacity of pump _____ Static level of completed well _____ ft.
 Depth of pump setting _____ Pump installed by _____

WELL LOG

SKETCH SHOWING LOCATION

Formations
 Sandstone, shale, limestone,
 gravel and clay

From To
 0 Feet 3 Feet

Locate in reference to numbered
 State Highways, St. Intersections, County roads, etc.

N.

op soil
Gravel & sand
water gravel
10 ft water
Dip test at approx
5 g.p.m.

2619
Kachle Ave
North Ridge
Dayton Ohio

Don't need

S.

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTHDate Sept 3-49Signed Earl HollandsworthAddress 553 E. Broad St., North Ridge

DAYTON, OHIO

48551

Signed _____

WELL LOG AND DRILLING REPORT

ORIGINAL

39

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No. 109299

County Montgomery Township Harrison Section of Township North East
Owner Herman Merhoff Address 2817 Koehler Ave
Location of property 1/2 mi north Traffic circle 1/2 mile
on S. 1st & North Ridge

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter 6 1/4" Length of casing 32'
Type of screen none Length of screen _____
Type of pump none
Capacity of pump _____
Depth of pump setting _____

Pumping rate 36 G.P.M. Duration of test 2 hr.
Drawdown none ft. Date 9-17-53
Developed capacity 216 gal per hr
Static level—depth to water 21
Pump installed by owner

WELL LOG

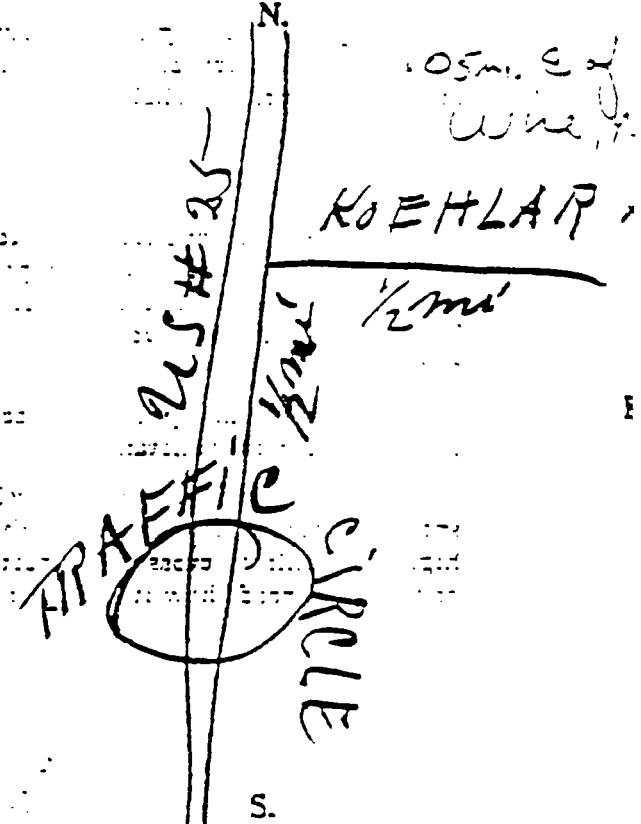
SKETCH SHOWING LOCATION

Formations
Sandstone, shale, limestone,
gravel and clay

From To
0 Feet 32 Feet

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.

Gravel
11 ft standing
water no drawdown



DAVID L. SULLIVAN

GEORGE WATERWELL DRILLING
PUMPS INSTALLED

4917 Woodland Hills Blvd

Dayton, Ohio

All Work Guaranteed

TA 3684

See reverse side for instructions

Drilling Firm David Sullivan Date Sept 17-1953
Address 4917 Woodland Hills Blvd Signed David L. Sullivan

21,526,000

WELL LOG AND DRILLING REPORT

ORIGIN

(500 x 500)

OHIO WATER RESOURCES BOARD

553 E. Broad St., Columbus 15, Ohio

No. 49181

County Montgomery Township Harrison Section of Township
or Lot NumberOwner Ray Smart Address 2711 Sheron StLocation of property inside south of Needmore Rd. and 1/2 mile
west of RT 25

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 89

Type of screen _____ Length of screen _____

Type of pump Jet

Capacity of pump _____

Depth of pump setting _____

PUMPING TEST

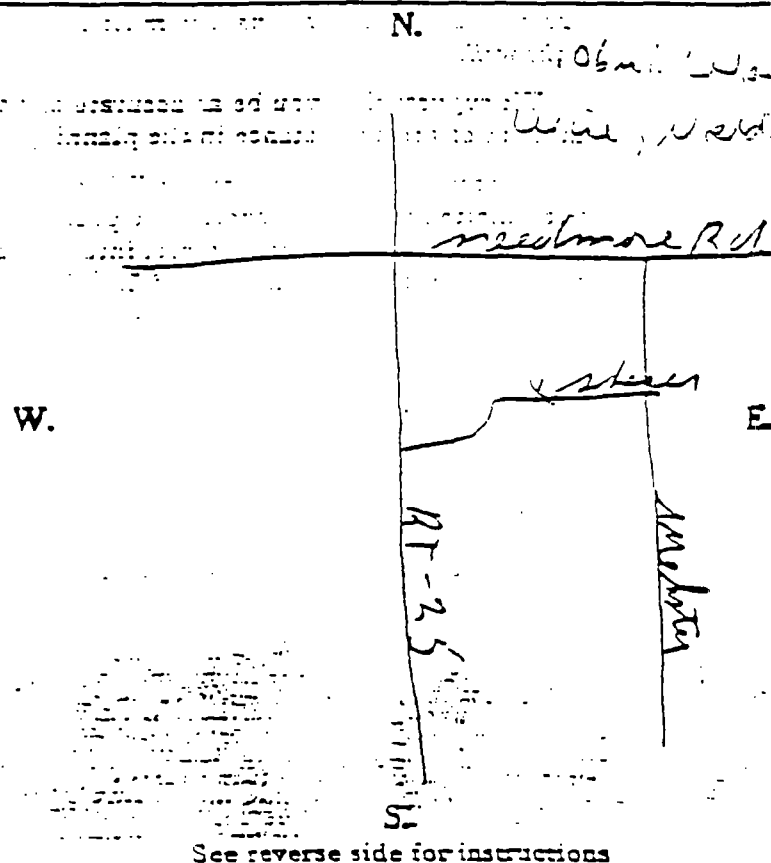
Pumping rate _____ G.P.M. Duration of test _____ hr

Drawdown 5 ft. Date _____Developed capacity 1200 gals per hr.Static level of completed well 34 ft.Pump installed by R. B. Billman Co

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
<u>fill</u>	0 Feet	<u>2</u> Ft.
<u>dry gravel</u>	6	47
<u>Hardpan</u>	47	55
<u>clay & gravel</u>	55	65
<u>fine sand</u>	60	75
<u>Hardpan</u>	75	77
<u>muddy sand</u>	77	83
<u>Hardpan</u>	83	85
<u>water bearing sand & gravel</u>	85	89

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.Drilling Firm W. V. SeatonDate 9-6-54Address P.O. Box 210-B Dayton, O.Signed W. V. Seaton

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

N? 129071

County Montgomery Township Harrison Section of Township
or Lot Number

Owner Wilbert Minnich Address 1100 Ross Ave.

Location of property North on Super High Way East on Kennan Ave 2 Blocks on Ross

CONSTRUCTION DETAILS

PUMPING TEST

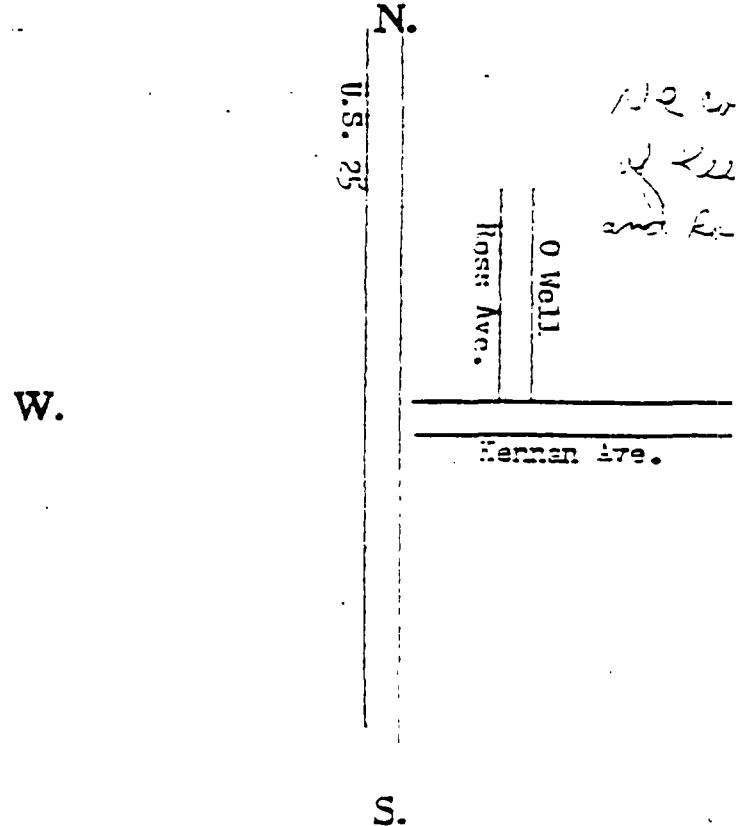
Casing diameter <u>1 1/2"</u>	Length of casing <u>17 Ft.</u>	Pumping rate _____ G.P.M.	Duration of test _____
Type of screen _____	Length of screen _____	Drawdown _____ ft.	Date <u>April 29 1954</u>
Type of pump _____		Developed capacity _____	
Capacity of pump _____		Static level—depth to water _____	<u>28</u>
Depth of pump setting _____		Pump installed by _____	

WELL LOG

SKETCH SHOWING LOCATION

Formations Sandstone, shale, limestone, gravel and clay	From	To
Gravel	0 Feet	30 Ft.
Gravel & Water	30 "	47 "

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc



See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH
Well Drilling
Address 225 Ohio Avenue - North Ridge
DAYTON, OHIO

Date April 29 1954
Signed Earl Hollandsworth

WELL LOG AND DRILLING REPORT

ORIGINAL

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

No 300566

County Montgomery Township Madison Section of Township North
Owner Howard Wick Address 2615 Neff Rd. Dayton, Ohio
Location of property 2615 Neff Rd Dayton Ohio

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter <u>5 1/2</u> Length of casing <u>63'</u>	Pumping Rate <u>20</u> G.P.M. Duration of test <u>1 1/2</u> hrs.
Type of screen <u>No 10</u> Length of screen <u>—</u>	Drawdown <u>5'</u> ft. Date <u>JAN - 16 - 64</u>
Type of pump <u>Lot or Deep Well</u>	Static level-depth to water <u>70</u> ft.
Capacity of pump <u>4 GPM</u>	Quality (clear, cloudy, taste, odor) <u>PLAIN</u>
Depth of pump setting <u>50'</u>	Pump installed by <u>Chas E. Hamilton</u>
Date of completion <u>JAN 16 - 64</u>	

WELL LOG			SKETCH SHOWING LOCATION
Formations Sandstone, shale, limestone, gravel and clay	From	To	Locate in reference to numbered State Highways, St. Intersections, County roads, etc.
CLAY	0 Feet	<u>4</u> Ft.	
GRAVEL	<u>4</u>	<u>55</u>	
BLUE CLAY	<u>55</u>	<u>60</u>	
SAND + GRAVEL	<u>60</u>	<u>63</u>	
WATER AT 60-63 FT.			
188 JAN 20 1964			See reverse side for instructions

Drilling Firm Chas E. Hamilton

Date Jan - 16 - 64

Address 616 W. 1st Ave.

Signed Chas E. Hamilton

WEI LOG AND DRILLING REPORT

ORIGINAL

UG 21

NO. CARBON PAPER
NECESSARY—
SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 420727

County Montgomery Township Hermantown Section of Township 12

Owner Village of Hermantown Address Hermantown, Ohio 45322

Location of property _____

CONSTRUCTION DETAILS

Casing diameter 10" Length of casing 42'
Type of screen R.B. Length of screen 7'
Type of pump None
Capacity of pump _____
Depth of pump setting _____
Date of completion _____

BAILING OR PUMPING TEST (Specify one by circling)

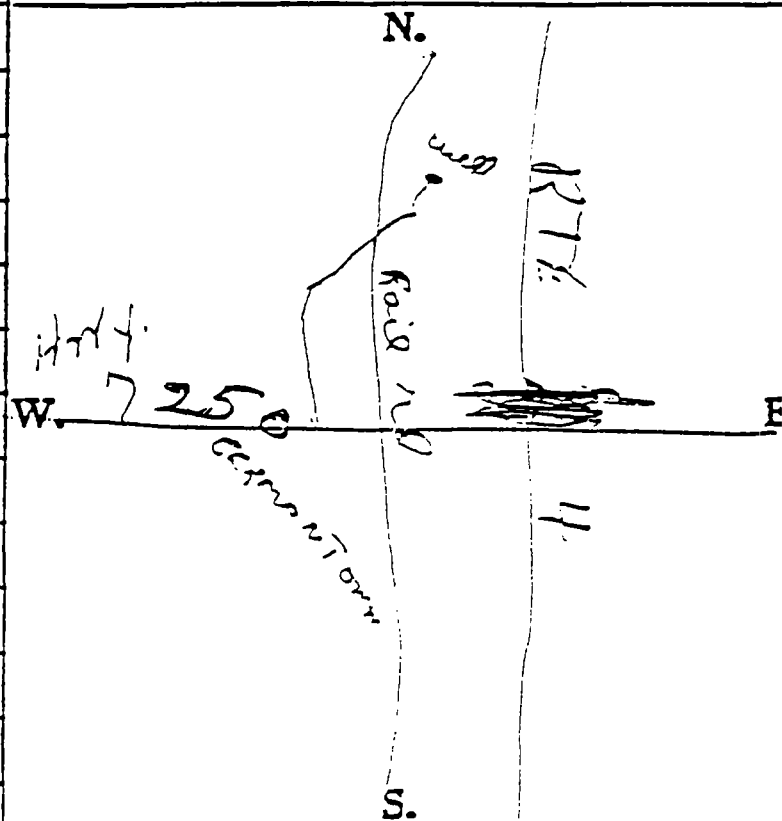
Test Rate 367 G.P.M. Duration of test 7 1/2
Drawdown 24' 3" ft. Date March 19, 1972
Static level-depth to water 11'
Quality (clear, cloudy, taste, odor) Clear
Pump installed by _____

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
<u>Top Soil</u>	<u>0 Feet</u>	<u>3 Ft.</u>
<u>Gravel</u>	<u>3'</u>	<u>8'</u>
<u>Gravel (dry)</u>	<u>8'</u>	<u>13'</u>
<u>Clay</u>	<u>13'</u>	<u>16'</u>
<u>Gravel - boulders</u>	<u>16'</u>	<u>25'</u>
<u>Gravel</u>	<u>25'</u>	<u>29'</u>
<u>Gravel - red sand</u>	<u>29'</u>	<u>34'</u>
<u>Sandy clay</u>	<u>34'</u>	<u>40'</u>
<u>Gravel</u>	<u>40'</u>	<u>42'</u>

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



Drilling Firm MOODY'S OF DAYTON, INC.

Date Dec 8, 1975

Address P.O. Box 123

Signed C.O. Burges

4359 Intermory Road
Viamisburg, Ohio 45342
513-859-4422

#15 additional st---

complete well log use next consecutive numbered form

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 111070

County Montgomery Township Harrison Section of Township or Lot Number
Owner Richard Brandon Address 2216 Wiffard Rd. Dayton, Ohio
Location of property Intersection Super Highway and Wiffard

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter 5" Length of casing 53'
Type of screen Length of screen
Type of pump
Capacity of pump
Depth of pump setting

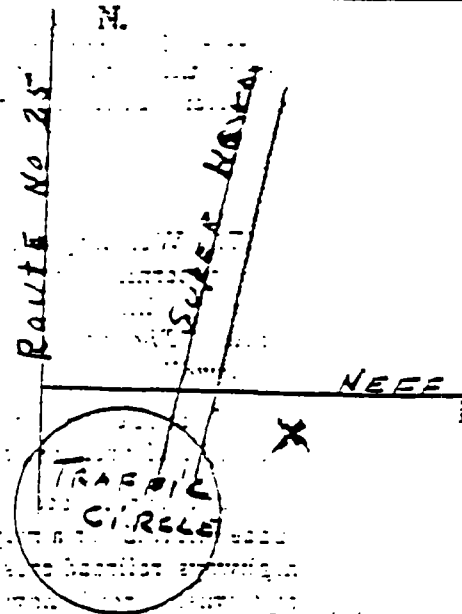
Pumping rate 12 1/2 G.P.M. Duration of test 1 h
Drawdown 3 ft. Date 2-28-54
Developed capacity 250 gals per min
Static level—depth to water 28
Pump installed by

WELL LOG

SKETCH SHOWING LOCATION

Formations Sandstone, shale, limestone, gravel and clay	From	To
Bl. clay	0 Feet	1.5 Ft.
Gravel & clay	1.5	3.2
gravel	3.2	3.7
Bl. clay	3.7	5.1
gravel	5.1	5.3
water	5.1 - 5.3	

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

S. and Mont

See reverse side for instructions

Drilling Firm M. J. Spencer
Address 2406 Linnwood Ave.

Date Feb 28, 1954
Signed Marion J. Spencer

WELL LOG AND DRILLING REPORT

ORIGIN.

9

State of Ohio.
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 136521

County Montgomery Township Harrison Section of Township 15
or Lot Number

Owner Northridge School Board Address

Location of property Griffin Kennedy School Wagner Ford R

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter 6" OD Length of casing 115'

Type of screen Coarse #60 Length of screen 8'

Type of pump Vertical Submersible

Capacity of pump 1500 G.P.M.

Depth of pump setting 80'

Pumping rate 40 G.P.M. Duration of test 8

Drawdown 0 ft. Date 9-1-54

Developed capacity 40 G.P.M.

Static level—depth to water 30'

Pump installed by W. S. Williams

WELL LOG

SKETCH SHOWING LOCATION

Formations
Sandstone, shale, limestone,
gravel and clay

From.

To

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc

0 Feet

Ft.

sandy clay

0

21

sandy and clay

21

70

sand

70

105

red gravel

105

115

N.

W.

Road 25

Well
OD

Wagner Ford R

S.

See reverse side for instructions

Drilling Firm W. S. Williams

Date 9-1-54

Address Rt 2 Minerva

Signed W. S. Williams

N.C.

WELL-LOG AND DRILLING REPORT

ORIGINAL

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

No 278540⁹⁰

County Montgomery Township Paris Section of Township 15
Owner Beard & Co. Inc. Address 3680 Wagner Road
Location of property 1/2 mile east of RR 75 on Wagner Road

CONSTRUCTION DETAILS

Casing diameter 5 1/2 Length of casing 100
Type of screen Length of screen
Type of pump
Capacity of pump
Depth of pump setting
Date of completion

BAILING OR PUMPING TEST

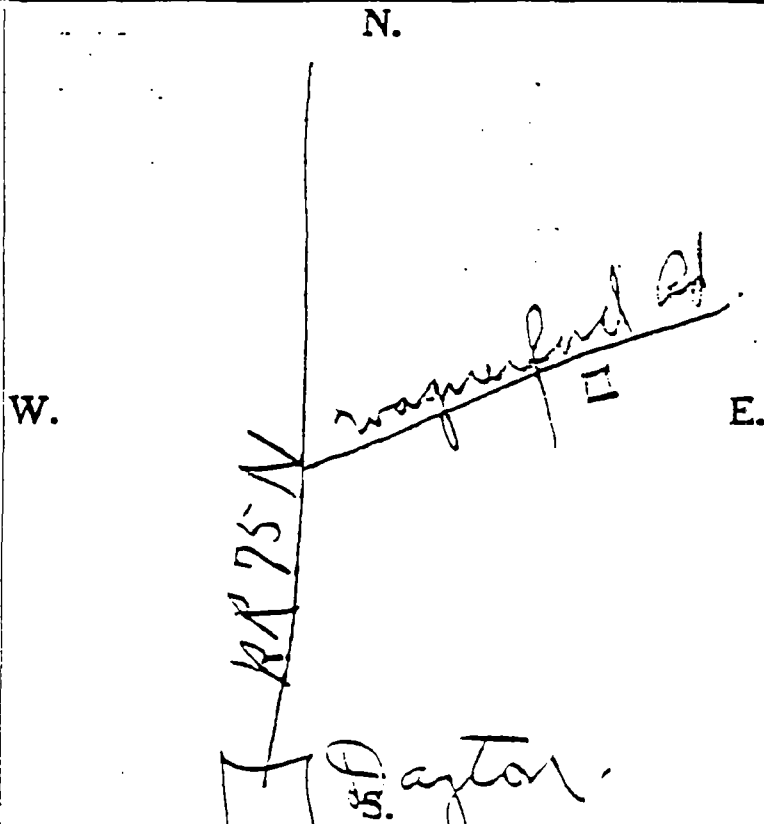
Pumping Rate 10 G.P.M. Duration of test 1 hrs.
Drawdown 5 ft. Date Sept 1 1966
Static level-depth to water 95' ft.
Quality (clear, cloudy, taste, odor) Clear
Pump installed by

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	20 Ft.
sand gravel	20	42
Clay	42	59
gravel	59	60

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, Country roads, etc.



See reverse side for instructions

Drilling Firm CLAY P. GARRISON
WELL CONTRACTOR
Address 3301 S. JIXIE DR.
CAYTON 3, OHIO

Date Sept 2 1966
Signed Clay P. Garrison

11,537,200
(1000 x 11.5372)
11,537,200 - 5

WELL LOG AND DRILLING REPORT

ORIGIN.

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

H ✓
N? 129088

County Montgomery Township Harrison Section of Township Northridge
or Lot Number Northridge

Owner Robert M. Burke Address 3300 Susannah Avenue Dayton 4, Ohio

Location of property Susannah Avenue Northridge, Dayton 4, Ohio

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter 1 1/2" Length of casing 37'

Pumping rate G.P.M. Duration of test

Type of screen Length of screen

Drawdown ft. Date

Type of pump

Developed capacity

Capacity of pump

Static level—depth to water

Depth of pump setting

Pump installed by

WELL LOG

SKETCH SHOWING LOCATION

Formations
Sandstone, shale, limestone,
gravel and clay

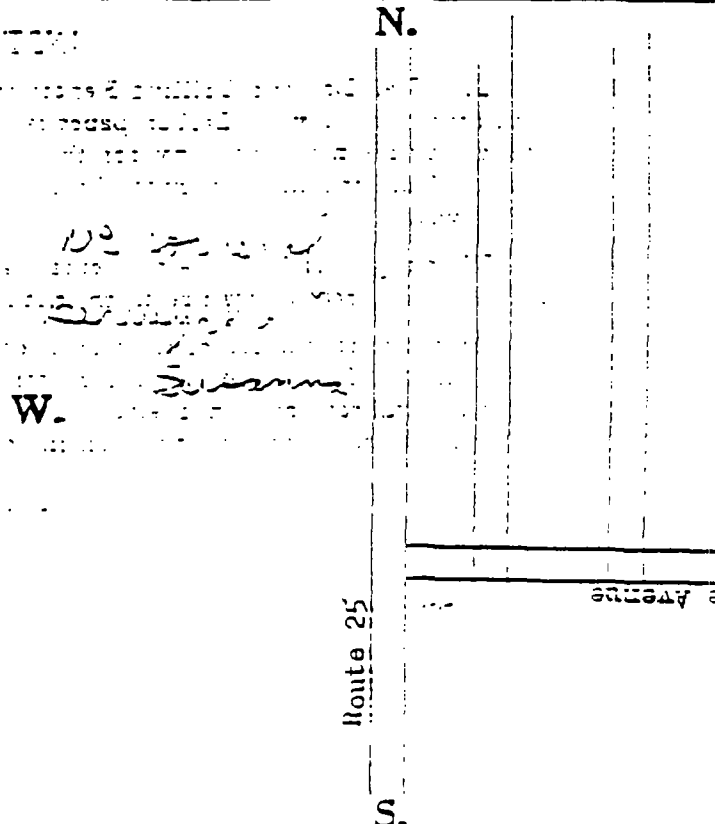
From To

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc

Formations	From	To
Top soil	0 Feet	2 Ft.
Sand and Gravel	2	12
Boulders	12	14
Sand	14	33
Clay and Gravel	33	35
Sand and Gravel, Water	35	37

Dip test at approx.

10 P.M.



See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH, Inc.

Date June 10 1954

Address 2538 Ave Avenue Dayton, Ohio

Signed Earl Hollandsworth, Inc.

ORIGINAL

Department of Public Works

15

Location of property 2509 Neva Avenue 4 blocks East of State Route 25 3 blocks North of the
Great Miami River.

PUMPING TEST

Casing diameter 1 1/2" Length of casing 36' Pumping rate _____ G.P.M. Duration of test _____ hr.

Type of screen _____ Length of screen _____ Drawdown _____ ft. Date _____

Type of pump _____ Developed capacity _____

Capacity of pump _____ Static level of completed well 0' ft.

Depth of pump setting _____ Pump installed by _____

SKETCH SHOWING LOCATION

To

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.

Top Soil	0 Feet	4 Ft.
Clay	4	14
Clay & Gravel	14	20
Sand, some Gravel	20	36

Die test at approx.

12 C.M.

N

2509

Neva Avenue
North Ridge

W.

The Great Miami River

5.

See reverse side for instructions

Drilling Firm.  Well-Drilling

Date 2 June 1966 76 1733

Address DAYTON, OHIO

Signed Earl Hall Anderson

WELL LOG AND DRILLING REPORT

OHIO WATER RESOURCES BOARD

553 E. Broad St., Columbus 15, Ohio

County Montgomery Township Harrison Section of Township North Ridge
 Owner L. W. Edmond Address 2474 Enclave
 Location of property 2474 Enclave and North Ridge

CONSTRUCTION DETAILS

Casing diameter 5 1/4 Length of casing 38'
 Type of screen _____ Length of screen _____
 Type of pump None
 Capacity of pump _____
 Depth of pump setting _____

PUMPING TEST

Pumping rate _____ G.P.M. Duration of test _____
 Drawdown _____ ft. Date _____
 Developed capacity _____
 Static level of completed well _____ ft.
 Pump installed by _____

WELL LOG

Formations: Sandstone, shale, limestone, gravel and clay	From	To
Loose gravel	0 Feet.	20 Ft.
Water gravel	20	25
Blue clay & gravel	25	32
Sand & gravel	32	38
2 ft. water		

Dip Test at
 2 ft. at 20 G.P.M.
 No draw down

SKETCH SHOWING LOCATION

Locate in reference to numbered
 State Highways, St. Intersections, County roads, etc.

Sketch showing location of well. Includes handwritten notes: "10 ft. well", "Enclave", "US Rt 25".

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH
 Well Drilling
 Address 2308 One Avenue North Ridge
DAYTON, OHIO

Date 8-21-45
 Signed Earl Hollandsworth

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 146319

County Montgomery Township Harrison Section of Township Northridge
or Lot Number
Owner Lester E. Brinkers Address 2516 Oneida Avenue Dayton 1, Ohio
Location of property 2516 Oneida Avenue (Northridge) Dayton 1, Ohio

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter <u>1 1/2"</u>	Length of casing <u>121'</u>	Pumping rate <u> </u> G.P.M.	Duration of test <u> </u>
Type of screen <u> </u>	Length of screen <u> </u>	Drawdown <u> </u> ft.	Date <u> </u>
Type of pump <u>Hand pump</u>		Developed capacity <u> </u>	
Capacity of pump <u> </u>		Static level—depth to water <u>9'</u>	
Depth of pump setting <u> </u>		Pump installed by <u> </u>	

WELL LOG

SKETCH SHOWING LOCATION

Formations	From	To
Sandstone, shale, limestone, gravel and clay		
Top soil	0 Feet	3 Ft.
Clay	3	9
Clay and Gravel	9	15
Sand and Gravel, Silt	15	35
Sand and Gravel	35	42

Dip test at approx.

10 G.P.M.

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

W.

S.

See reverse side for instructions

RECEIVED

Drilling WILLIAM W. WILKINS, INC.
Address 5012 Shell Road
Dayton 1, Ohio

Date August 24, 1955

Signed William W. Wilkins

WELL LOG AND DRILLING REPORT

OHIO WATER RESOURCES BOARD

553 E. Broad St., Columbus 15, Ohio

County Montgomery Township Harrison Section of Township 15 or Lot Number 15
 Owner F. Turrell Address 1514 One Avenue Dayton 4, Ohio
 Location of property 4 Blocks East of U.S. State Route 25. North edge of Dayton, O. Along the Miami River.

CONSTRUCTION DETAILS

Casing diameter 1 1/2" Length of casing 38'
 Type of screen _____ Length of screen _____
 Type of pump _____
 Capacity of pump _____
 Depth of pump setting _____

PUMPING TEST

Pumping rate _____ G.P.M. Duration of test _____ hr
 Drawdown _____ ft. Date _____
 Developed capacity _____
 Static level of completed well 15 ft.
 Pump installed by _____

WELL LOG

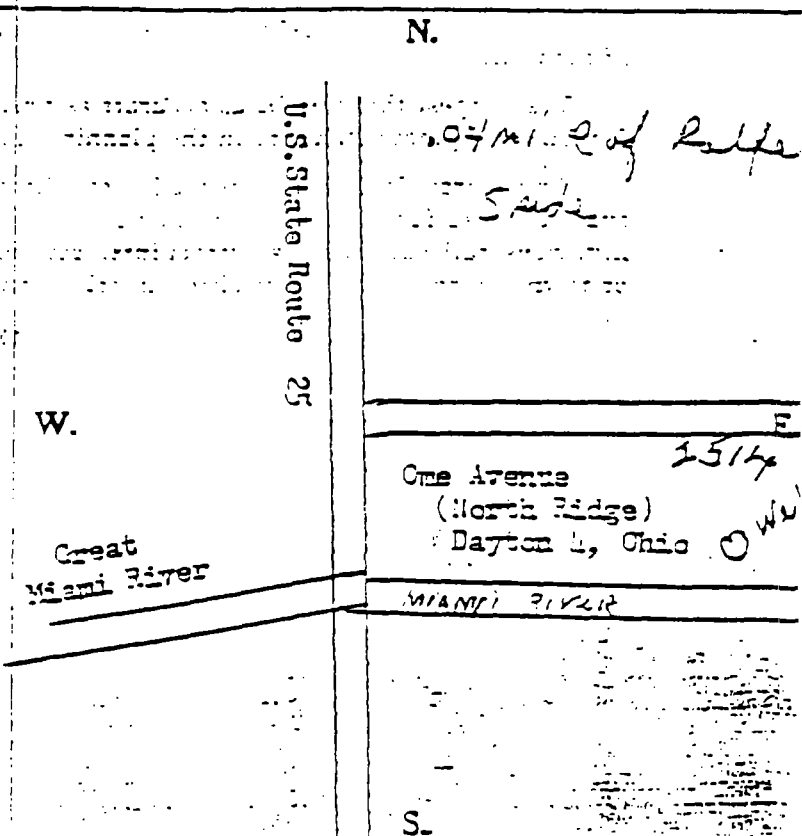
Formations	From	To
Sandstone, shale, limestone, gravel and clay		
Top soil	0 Feet	2 Ft.
Gravel & Sand	2	38

DIP Test
 at approx.

70 G.P.M. DRAG SECTION FOR 10'

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

EARL HOLLANDSWORTE

Drilling Firm Well Drilling
 Address 253 One Avenue - North Ridge DAYTON, OHIO

Date June 15 1953
 Signed Earl Hollandsworthe

ORIGINAL

(10421000)

4. 646,8005

DEPARTMENT OF NATURAL RESOURCES

Division of Water

Columbus, Ohio

Nº 109453

County Montgomery Township Harrison Section of Township
or Lot Number North Bridge

Owner James Franklin Welch Address 2704 One Avenue Dayton, Ohio

Location of property Lot 14, Enderly Flat, North bank of the Great Miami River.

PUMPING TEST

Casing diameter 1 1/4" Length of casing 50'
Type of screen Length of screen
Type of pump
Capacity of pump
Depth of pump setting

Pumping rate _____ G.P.M. Duration of test _____ hr
 Drawdown _____ ft Date _____
 Developed capacity _____
 Static level—depth to water _____
 Pump installed by _____

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.

Formations	From	To
Sandstone, shale, limestone, gravel and clay		
Top Soil	0 Feet	<u>1</u> Ft.
Clay	1	40
Clay, some Gravel	40	52
Sand and Gravel, Water	52	54

[illegible]

DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife
Columbus, Ohio

52-1704-5319

U.S. 25

N.

Str. 5-1940

of Salento

NORTH BRIDGE

ONE AVENUE

W.

E

THE GREAT RIVER

S.

See reverse side for instructions

Drilling Firm: EARL HOLLANDSWORTH
Well Drilling
 Address: 2538 One Avenue - North Ridge
DAYTON, OHIO

Date 8-11-53
Signed Earl F. Williams

ΔC

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER
NECESSARY—
SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 315 Phone (614) 469-2646
Columbus, Ohio 43215

No. 398215

County Montgomery Township Harrison Section of Township 15
Owner First Day Industries Address 2801 Ontario w.
Location of property corner of Ontario w. and Fairfield w.

CONSTRUCTION DETAILS

Casing diameter 5 3/4 Length of casing 77
Type of screen _____ Length of screen _____
Type of pump _____
Capacity of pump _____
Depth of pump setting _____
Date of completion _____

BAILING OR PUMPING TEST (Specify one by circling)

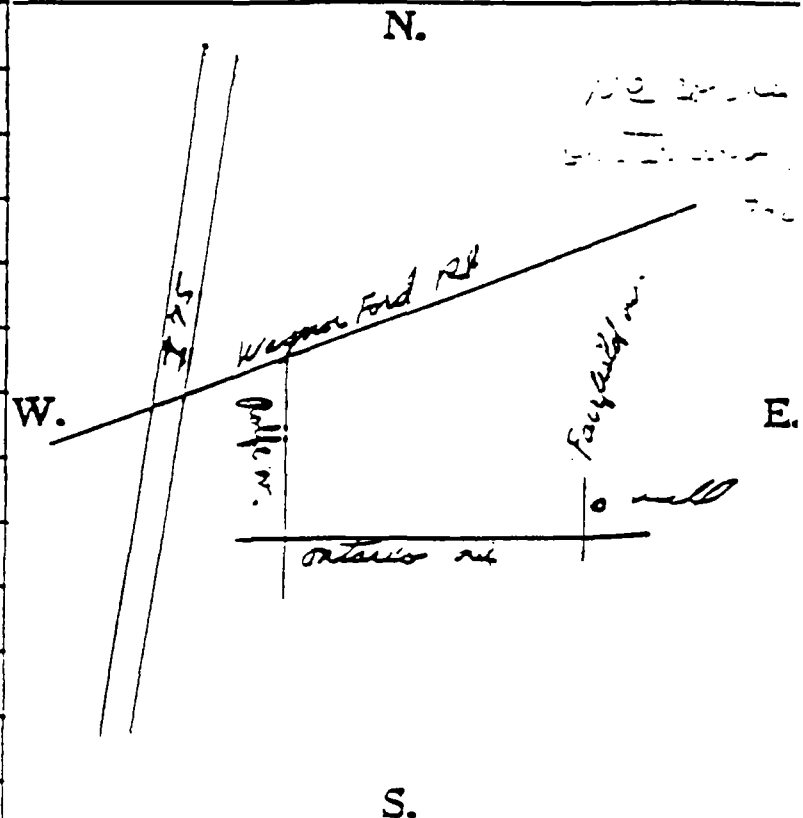
Test Rate 40 G.P.M. Duration of test _____ hrs
Drawdown 50 ft. Date Sept 69
Static level-depth to water 21 ft.
Quality (clear) (cloudy, taste, odor) _____
Pump installed by Cummins

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
<u>4" gravel</u>	<u>0 Feet</u>	<u>22 Ft</u>
<u>Drum water</u>	<u>22</u>	<u>23</u>
<u>Shy gravel</u>	<u>23</u>	<u>52</u>
<u>Sand</u>	<u>52</u>	<u>75</u>
<u>gravel water</u>	<u>75</u>	<u>77</u>

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



Drilling Firm Burns Well Drilling
Address Tipp city

Date Sept 24 69
Signed Donald H. Brown

T. v.

1.

599538

NO CARBON PAPER
NECESSARY -
SELF-TRANSCRIBING

Fountain Square
Columbus, Ohio 43224

COUNTY Montgomery TOWNSHIP Mad River SECTION OF TOWNSHIP 31 ✓
OWNER Kathleen Krasjiga ADDRESS 2907 Old Troy Pike
LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST (Specify one by circling)
Casing diameter <u>6</u> Length of casing <u>120</u>	Test rate <u>10</u> gpm Duration of test <u>10</u>
Type of screen _____ Length of screen _____	Drawdown <u>4</u> ft Date <u>4 Dec 1981</u>
Type of pump <u>Sub-</u>	Static level (depth to water) <u>52'</u>
Capacity of pump <u>10 GPM</u>	Quality (clear, cloudy, taste, odor) <u>Clear</u>
th of pump setting <u>100</u>	Pump installed by <u>S. C. Patterson</u>
Date of completion <u>6 Dec. 1981</u>	

[illegible]

DRILLING FIRM Paterson Well Co. DATE 6 Dec 1981
ADDRESS 5001 S Dixie Dr SIGNED J C Paterson

* If additional space is needed to complete writ log, use next consecutive numbered form.

ORIGINAL

478848

W

N

COMMUNITIES

DATE 10-7-70
SIGNED Mrs. O. A. Dist

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER
NECESSARY -
SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

478823

COUNTY Montgomery TOWNSHIP Mad River SECTION OF TOWNSHIP 36
OR LOT NUMBER

OWNER William Watt ADDRESS 2503 Troy Pike Dayton

LOCATION OF PROPERTY 1/2 mile south of Community Dr. on Troy Pike

CONSTRUCTION DETAILS

BAILING OR PUMPING TEST

(Specify one by circling)

Casing diameter 6" Length of casing 73 ft. Test rate 25 gpm Duration of test 10-9-75
Type of screen Length of screen Drawdown 4 ft Date 10-9-75
Type of pump submersible Static level (depth to water) 37
Capacity of pump 1/2 h.p. Quality (clear, cloudy, taste, odor) clear
Depth of pump setting 65 ft Pump installed by Scott Well & Pump Co.
Date of completion 10-10-75

WELL LOG*

SKETCH SHOWING LOCATION

Formations: sandstone, shale,
limestone, gravel, clay

From

To

Locate in reference to numbered
state highways, street intersections, county roads, etc.

topsoil

0 ft

5 ft

dry gravel

5

27

hardpan

27

32

mushy sand & gravel

32

40

water gravel

40

73

W

N

COMMUNITY DR

S

DRILLING FIRM Scott Well & Pump Co.

DATE 10-10-75

ADDRESS 5850 Brantford Rd.

SIGNED [Signature]

County Permit No.

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio

DEPARTMENT OF NATURAL RESOURCES

551557

Division of Water

Fountain Square

Columbus, Ohio 43224

NO CARBON PAPER

NECESSARY

SELF-TRANSCRIBING

COUNTY Montgomery TOWNSHIP McRuer SECTION OF TOWNSHIP 36
 OWNER John Sullivan ADDRESS 2627 Old Tracy Pike
 LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

Casing diameter 5" Length of casing 72'
 Type of screen _____ Length of screen _____
 Type of pump Submersible
 Capacity of pump 12
 Depth of pump setting 73'
 Date of completion 4-30-80

BAILING OR PUMPING TEST
(Specify one by circling)

Test rate 10 gpm Duration of test 1 hr
 Drawdown 20 ft Date 4-24-80
 Static level (depth to water) 40
 Quality (clear) cloudy, taste, odor _____

Pump installed by Jenkins Pump Service

WELL LOG*

Formations: sandstone, shale,
limestone, gravel, clay

From

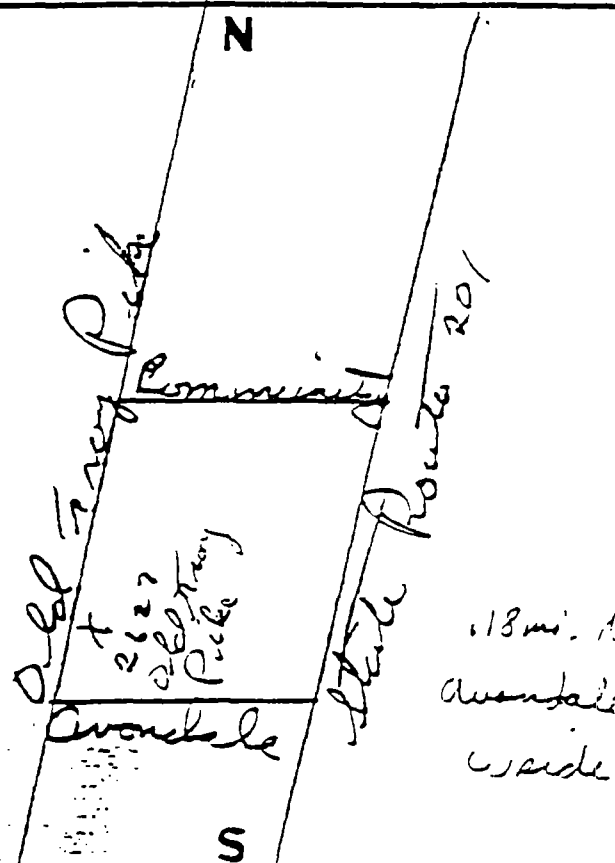
To

<u>Topsoil</u>	<u>0 ft</u>	<u>5 ft</u>
<u>Loose sand</u>	<u>5</u>	<u>45</u>
<u>Loose clay</u>	<u>45</u>	<u>47</u>
<u>Sand</u>	<u>47</u>	<u>56</u>
<u>Loose clay</u>	<u>56</u>	<u>64</u>
<u>Loose sand</u>	<u>64</u>	<u>70</u>
<u>Sand - sand</u>	<u>70</u>	<u>78</u>

SKETCH SHOWING LOCATION

Locate in reference to numbered
state highways, street intersections, county roads, etc.

W



DRILLING FIRM

ADDRESS

DATE

SIGNED

WELL-LOG AND DRILLING REPORT

ORIGIN

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

No. 332465

County Montgomery Township Mad River Section of Township 3
Owner Robert Wilson Address 2121 Troy St.
Location of property 2121 Troy St.

CONSTRUCTION DETAILS

Casing diameter 5 7/8 Length of casing 60
Type of screen _____ Length of screen _____
Type of pump _____
Capacity of pump _____
Depth of pump setting _____
Date of completion _____

BAILING OR PUMPING TEST

Pumping Rate 12 G.P.M. Duration of test 2 hr
Drawdown 5 ft. Date June 9 1965
Static level-depth to water 215
Quality (clear) (cloudy, taste, odor) _____
Pump installed by _____

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
<u>Clay</u>	0 Feet	4 Ft.
<u>gravel sand</u>	4	38
<u>Clay</u>	38	59
<u>gravel</u>	59	60

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.

N.

W.

E.

S.

See reverse side for instructions

Drilling Firm CLAY P. GARRISON
Address WELL CONTRACTOR

Date June 10 1965
Signed Clay P. Garrison

3901 S. DIXIE DR.
DAYTON 3, OHIO
If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

PLEASE USE PENCIL. DEPARTMENT OF NATURAL RESOURCES
FOR TYPEWRITER. Division of Water
DO NOT USE INK 1562 W. First Avenue
Columbus, Ohio

No. 248078

County MONTGOMERY Township MADRIER Section of Township 36

Owner MIKE HECK Address 2216 TROY ST DAYTON

Location of property _____

CONSTRUCTION DETAILS

Casing diameter 5 3/4 Length of casing 70
Type of screen _____ Length of screen _____
Type of pump _____
Capacity of pump _____
Depth of pump setting _____
Date of completion _____

BAILING OR PUMPING TEST

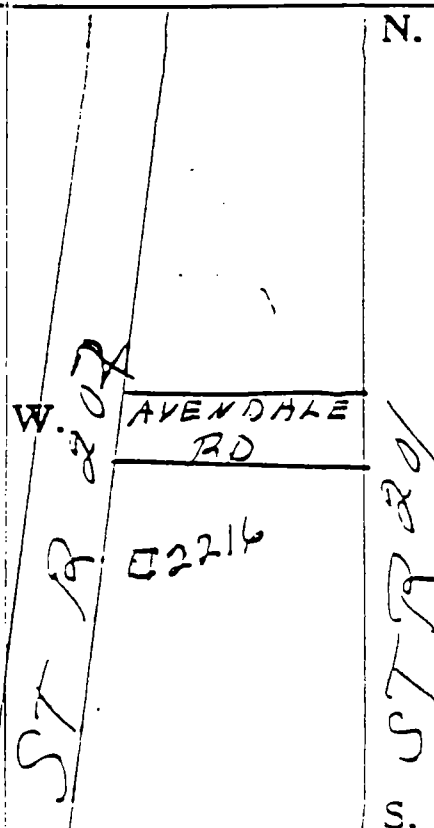
Pumping rate 70 G.P.M. Duration of test _____
Drawdown 5 ft. Date Dec 12-60
Developed capacity 1800
Static level—depth to water 35
Pump installed by _____

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
CLAY	0 Feet	8 Ft.
BCLAY & GRAVEL	8	32
BCLAY & SAND	32	54
BCLAY	54	65
GRAVEL	65	70

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



200 feet south of
Avendale Rd on
St R 202 East side

See reverse side for instructions

Drilling Firm _____

Date Dec 12-60

Address _____

Signed John Brenner

WELL LOG AND DRILLING REPORT

State of Ohio

PLEASE USE PENCIL DEPARTMENT OF NATURAL RESOURCES

OR TYPEWRITER

DO NOT USE INK

Division of Water

1562 W. First Avenue

Columbus, Ohio

No. 248

County MONTGOMERY Township Mad River Section of Township 36

Owner A. G. B. E. C. H. I. E. Address 2414 TRD ST

Location of property DAYTON OHIO

CONSTRUCTION DETAILS

Casing diameter 5 5/8 Length of casing 83
 Type of screen Length of screen
 Type of pump Submersible
 Capacity of pump 600
 Depth of pump setting 70
 Date of completion MAY 20-61

BAILING OR PUMPING TEST

Pumping rate 30 G.P.M. Duration of test
 Drawdown 10 ft. Date MAY 20-61
 Developed capacity
 Static level—depth to water 30
 Pump installed by JOHN BRENNER

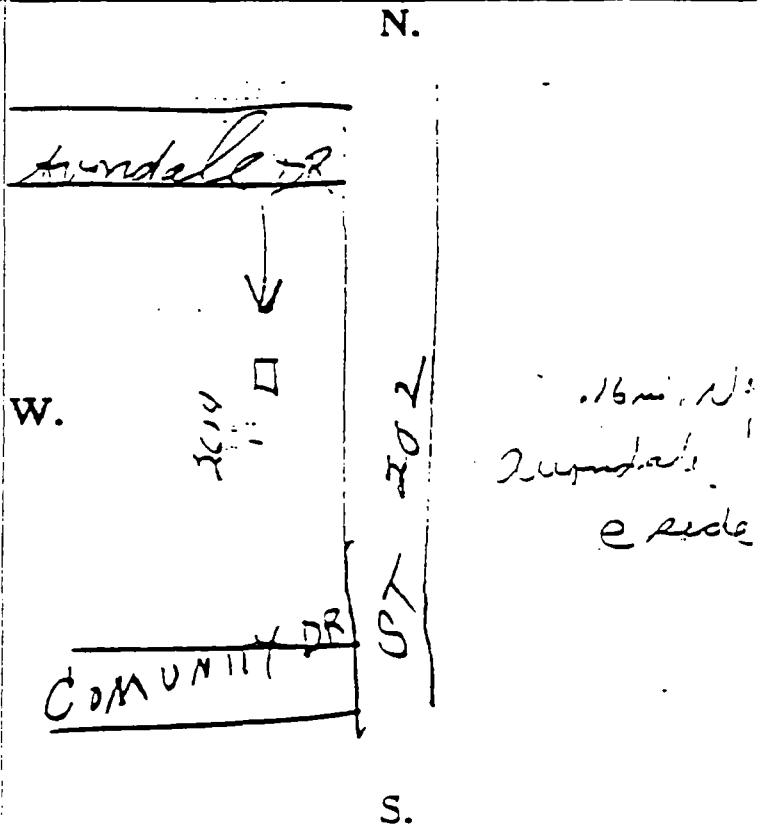
WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
<u>CLAY</u>	<u>0 Feet</u>	<u>5 Ft.</u>
<u>GRAVEL</u>	<u>50</u>	<u>50</u>
<u>CLAY</u>	<u>50</u>	<u>59</u>
<u>SAND</u>	<u>59</u>	<u>80</u>
<u>GRAVEL</u>	<u>80</u>	<u>83</u>

*600 feet North of
Woodale DR*

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm

Address

Date MAY 20-61

Signed John H Brenner

WELL LOG AND DRILLING REPORT

ORIG:

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 128409

County Montgomery Township Madison Section of Township or Lot Number 36
Owner Donald Takacs Address _____
Location of property 112 Avondale Ave

CONSTRUCTION DETAILS

PUMPING TEST

Casing diameter <u>1 1/4"</u> Length of casing <u>80'</u>	Pumping rate _____ G.P.M. Duration of test _____
Type of screen _____ Length of screen _____	Drawdown _____ ft. Date _____
Type of pump _____	Developed capacity _____
Capacity of pump _____	Static level—depth to water _____
Depth of pump setting _____	Pump installed by _____

WELL LOG

SKETCH SHOWING LOCATION

Formations Sandstone, shale, limestone, gravel and clay	From	To	Locate in reference to numbered State Highways, St. Intersections, County roads, etc.
<u>Clay</u>	0 Feet	<u>7</u> Ft.	N.
<u>Gravel & sand</u>	<u>7</u>	<u>35</u>	
<u>Clay</u>	<u>35</u>	<u>78</u>	
<u>Gravel</u>	<u>78</u>	<u>80</u>	
			W.
			S.

See reverse side for instructions

Drilling Firm A E Lotbison
Address 2315 Valley St

Date June 11/54
Signed A E Lotbison

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

No. 218833

County Franklin Township Franklin Section of Township 35
Owner John E. Smith Address 1234 Main St.
Location of property 1234 Main St.

CONSTRUCTION DETAILS

BAILING OR PUMPING TEST

Casing diameter 5 1/2" Length of casing _____ Pumping rate 100 G.P.M. Duration of test 1 hrs.
Type of screen _____ Length of screen _____ Drawdown _____ ft. Date _____
Type of pump _____ Developed capacity _____
Capacity of pump _____ Static level—depth to water _____ ft.
Depth of pump setting _____ Pump installed by _____
Date of completion _____

WELL LOG

SKETCH SHOWING LOCATION

Formations Sandstone, shale, limestone, gravel and clay	From	To
top soil	0 Feet	10 Ft.
Shale	34	55
Sand	55	65
Blue mud	65	90
Shale	90	

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.

N.

W.

E.

S.

See reverse side for instructions

Drilling Firm A. E. Smith
Address 1234 Main St.

Date Nov. 29, 1958
Signed J. E. Smith

13413038
2231883 1958

WELL LOG AND DRILLING REPORT

ORIGIN

5a

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

No 297384

County Montgomery Township Mad River Section of Township _____

Owner Michael Pandizk Address 120 Avondale Avenue, Dayton 14, Ohio

Location of property 120 Avondale Avenue, Dayton, Ohio

CONSTRUCTION DETAILS

Casing diameter 5-3/8" Length of casing 74
Type of screen RED BRASS Length of screen 4'
Type of pump 200 G.P.M. 1/2 HP SUBMERSIBLE
Capacity of pump 650 GPH
Depth of pump setting 70 FT
Date of completion May 24, 1963

BAILING OR PUMPING TEST

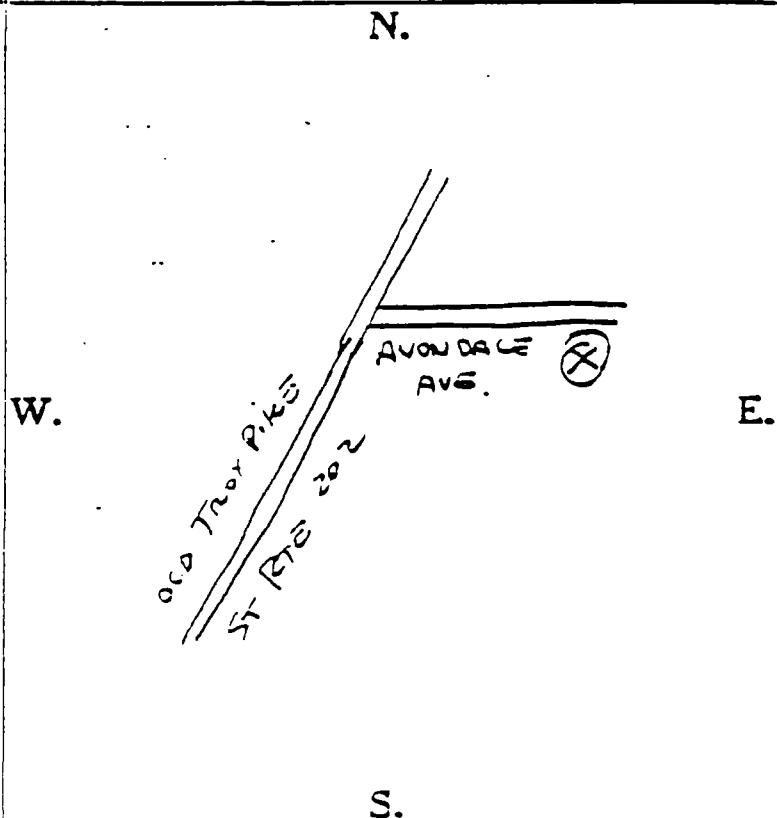
Pumping Rate 20 G.P.M. Duration of test 1 hrs
Drawdown 2 ft. Date 5/24/63
Static level-depth to water 43 ft
Quality (clear, cloudy, taste, odor) MURKY QUALITY
WILL CLEAR WITH PUMPING
Pump installed by OWNER

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
clay	0 Feet	5 Ft
dry gravel	5	50
loney sand	50	70
sand-water	70	77

SKETCH SHOWING LOCATION

Locate in reference to numbered
State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Moody's of Dayton, Inc.

Address P.O. Box 155, Wadsworth, Ohio

Date May 27, 1963

Signed Donald R. Bover

Donald R. Bover

X-4 53,600
(2000 x 2000)
= 653,300 - S

WELL LOG AND DRILLING REPORT
State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

ORIGINAL
5
No 129065

County Montgomery Township Mad. Bismar Section of Township 36
or Lot Number

Owner William H. Olson Address 110 Avondale Drive Dayton 1, Ohio

Location of property East Off Troy Pike about 1/8 of a mile on Avondale Dr.

CONSTRUCTION DETAILS	PUMPING TEST
Casing diameter <u>6"</u> Length of casing <u>81 Ft.</u>	Pumping rate <u> </u> G.P.M. Duration of test <u> </u>
Type of screen <u> </u> Length of screen <u> </u>	Drawdown <u> </u> ft. Date <u>April 9, 1954</u>
Type of pump <u> </u>	Developed capacity <u> </u>
Capacity of pump <u> </u>	Static level—depth to water <u> </u> <u>40</u>
Depth of pump setting <u> </u>	Pump installed by <u> </u>

WELL LOG			SKETCH SHOWING LOCATION
Formations Sandstone, shale, limestone, gravel and clay	From	To	Locate in reference to numbered State Highways, St. Intersections, County roads, etc.
Top Soil	0 Feet	<u>5</u> Ft.	
Gravel	<u>5</u>	<u>35</u>	
Clay & Gravel	<u>35</u>	<u>50</u>	
Gravel & Water	<u>50</u>	<u>81</u>	
Dip Test at Approx. 10 G.P.M.			

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH
Well Drilling
Address 1000 Ohio Avenue North Ridge
DAYTON, OHIO

Date April 9, 1954
Signed Earl Hollandsworth

#14

**SITE INVESTIGATION REPORT
CHRYSLER CORPORATION
DAYTON THERMAL PRODUCTS PLANT
1600 WEBSTER STREET
DAYTON, OHIO 45404**

Volume I of III

Report Text

DAIMLERCHRYSLER DOCUMENT
CONTROL NO.

SC001.11082002.007

Prepared For

Chrysler Corporation
800 Chrysler Drive
CIMS 482-00-51
Auburn Hills, Michigan 48326-2757

Prepared By

Clean Tech
2700 Capitol Trail
Newark, DE 19711
(302) 999-0924

September, 1995



CLEAN TECH

Clean Tech, Inc
Environmental Consultants

2700 Capitol Trail
Newark, DE 19711
302-999-0924
FAX: 302-999-0925

September 14, 1995

DAIMLERCHRYSLER DOCUMENT
CONTROL NO.

SC001.11082002.007

Mr. Curtis Chapman
Chrysler Corporation
800 Chrysler Drive
CIMS 482-00-51
Auburn Hills, MI 48326-2757

**RE: Finalized Site Investigation Report
Chrysler Corporation Dayton Thermal Products Plant
Dayton, Ohio**

Dear Mr. Chapman:

Enclosed please find the three volume finalized document Site Investigation, Chrysler Corporation Dayton Thermal Products Plant, Dayton Ohio. This submittal includes your review comments and requested report revisions. Comments received from Mr. Doug Orf are incorporated in this final submittal. This document has been forwarded to Mr. Orf per your request.

If you have any questions, please contact Clean Tech at (302) 999-0924.

Sincerely,

Steven W. Newsom, P.G.
Principal Geologist
CLEAN TECH

Sincerely,

Deborah A. Buniski, P.E.
President
CLEAN TECH



CLEAN **TECH**

Clean Tech, Inc.
Environmental Consultants

2700 Capitol Trail
Newark, DE 19711
302-999-0924
FAX: 302-999-0925

September 14, 1995

Mr. Douglas J. Orf
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

**RE: Finalized Site Investigation Report
Chrysler Corporation Dayton Thermal Products Plant
Dayton, Ohio**

Dear Mr. Orf:

Enclosed please find the three volume finalized document Site Investigation, Chrysler Corporation Dayton Thermal Products Plant, Dayton Ohio. This submittal includes comments and requested report revisions as received from you and Mr. Curtis Chapman. This document has been forwarded to Mr. Chapman.

If you have any questions, please contact Clean Tech at (302) 999-0924.

Sincerely,

Steven W. Newsom, P.G.
Principal Geologist
CLEAN TECH

Sincerely,

Deborah A. Buniski, P.E.
President
CLEAN TECH

e:\usr-data\chrysler\corres.\sub995do.doc

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Executive Summary

Clean Tech completed this site investigation at Chrysler Corporation's Dayton Thermal Products Plant located at 1600 Webster Street in Dayton, Ohio. The objectives were:

- Characterize the type and extent of contaminants in the unsaturated zone (above the water table) and saturated soil zones;
- Characterize the extent of dissolved phase contaminants in the groundwater;
- Assess the source of contaminants;
- Evaluate the potential for migration of contaminants off site;
- Obtain site data useful for evaluating remediation technologies;
- Evaluate potential for contamination due to dense non-aqueous phase liquids (DNAPL).

A review of existing information sources, a soil vapor survey, soil and groundwater sampling, and a hydrogeologic assessment permitted identification of three recognizable areas of the subject property having volatile organic compound (VOC) contamination. Groundwater and soil contamination by VOCs was documented with contaminant sources located in the central portion of the site near Building 53, and below Buildings 40A and 40B. Soil and groundwater contamination which originated from some off-site source to the south also appears to have impacted the subject site. VOC contamination appears to have entered the site from the south under the influence of an induced groundwater flow gradient originating at the Gem City Chemicals facility. Contaminants in groundwater have the potential to migrate off-site toward the Gem City facility.

No contamination by DNAPLs was observed. Groundwater contamination appears restricted to the shallow unconfined aquifer. The semi-confined aquifer does not appear to be affected by VOC contamination at this time. However, available information indicates the potential exists for groundwater to move downward from the unconfined aquifer to the semi-confined aquifer.

Solvents containing chlorinated organic compounds are interpreted to have entered the subsurface environment and penetrated to a depth near the base of the vadose (unsaturated soil) zone. Groundwater in the unconfined aquifer was brought in contact with the contaminated soil allowing contaminants to be released into the groundwater. Groundwater flow in the unconfined aquifer moved the groundwater toward the northeast under the influence of the steepening hydraulic gradient induced by the pumping well at Gem City Chemicals, Inc. The groundwater flowing past the contaminant sources acquired dissolved contaminants and carried the contaminants across the site toward the northeast forming the observed contamination plumes.

As groundwater moved toward the northeast carrying dissolved contaminants from the source locations, the soils in contact with the moving groundwater plumes absorbed some of the contaminants. This formed broad soil contamination plumes and may account for the similarity in location and pattern for both the soil contaminant and groundwater contaminant plumes. Seasonal fluctuations in water levels would be expected to exacerbate this situation over time. Under these conditions, the potential for off-site transport of contaminants is significant over time, first as dissolved groundwater contamination, and secondly as soil contamination near the base of the vadose zone.

The Ohio EPA currently seeks only to prevent significant contamination from reaching nearby public water supply wells through a Well Field Protection Program with Interim Action requirements. Interim Actions for groundwater are the only approved remedial actions which may be undertaken within the Well Field Protection Area. The need for groundwater gradient control is based Ohio EPA defined Interim Standards. If an Interim Standard for groundwater quality is exceeded, Ohio EPA will require the property owner control and remediate contaminated groundwater to prohibit it from leaving the effected property. Fourteen of the twenty-one VOCs detected at the subject site exceed the Interim Standards for those compounds.

Section 1.0 - Introduction and Purpose

Clean Tech is pleased to present our report of findings for the Site Investigation completed at Chrysler Corporation's Dayton Thermal Products Plant (DTPP) in Dayton, Ohio. This plant is part of Chrysler Components, a division of Chrysler Corporation (Chrysler). The site is located at 1600 Webster Street in Dayton, Ohio as shown in Figure 1 (see Volume II of this report). The facility encompasses approximately 60 acres and contains over 1.3 million square feet under roof. Current operations at the facility include the manufacture, assembly, and finishing of heat exchangers and air conditioning components for motor vehicles. The facility consists of eight manufacturing buildings, a powerhouse, wastewater treatment plant, and associated storage buildings.

The facility is presently surrounded by the following industries: Brainerd Industries and Paint America Company on Webster Street, and American Lubricants and Gem City Chemical Company on Air City Avenue. There are several other industries and commercial operations in the near vicinity of the facility (DAP, Inc., Hohman Plating and Manufacturing, Gem City Stamping, Inc., RIS Paper Company, and Angell Manufacturing Company) in addition to private residences. A facility map which provides further details of the site including buildings and other operations is included as Figure 2 (see Volume II of this report).

Past operations at the site prior to Chrysler's acquisition in 1936 included the assembly of Maxwell automobiles from about 1907 through 1936, and other manufacturing processes such as furnaces, gun parts, aluminum and copper tube forming operations, light machining, plating, metal stamping, welding, soldering, degreasing, painting, plastic molding and assembly, as well as maintenance of these processes, equipment and structures. The Maxwell Complex, which was a group of twelve former buildings, was used by Chrysler until 1990 when it was demolished. The Maxwell Complex had been used primarily for storage purposes during the ten to twelve years prior to demolition. A

portion of the Maxwell Complex footprint was replaced by the new manufacturing Building 59 in 1991. Investigations completed during the demolition of the Maxwell Complex buildings (prior to the construction of Building 59) indicated that the site may have been impacted by historical manufacturing activities.

This site investigation was completed on behalf of Chrysler by Clean Tech of Newark, Delaware. Specifically, the objectives of the site investigation were as follows:

- Characterize the type and extent of contaminants in the vadose and saturated zones;
- Characterize the extent of dissolved phase contaminants in the groundwater;
- Assess the source of contaminants;
- Evaluate the potential for migration of contaminants off site;
- Obtain site data useful for evaluating remediation technologies; and
- Evaluate potential for contamination due to dense non-aqueous phase liquids (DNAPL).

The site investigation included the following:

- A review of existing information was conducted using sources which included aerial photographs (see Attachment A in Volume II), Sanborn maps, previous reports of limited investigations for the site, and documents describing investigations and remediation at nearby properties;
- A soil vapor survey was conducted to evaluate volatile organic compounds (VOCs) above the water table (vadose zone) for two distinct soil depth zones across the entire DTPP property using an on-site mobile laboratory;
- Soil borings were installed and subsurface soils were described and sampled for laboratory analysis of VOCs and selected metals. The installation of the soil

borings was completed using the results of the soil vapor survey as guidance for boring placement and selection of depth intervals for sampling;

- Monitoring wells were installed and the subsurface soils were described and sampled for laboratory analysis of VOCs and selected metals. The wells were screened at two distinct depths within the unconfined (water table) aquifer, and in the semi-confined aquifer. This was done to determine the nature and extent of groundwater contaminants. Two rounds of groundwater samples were collected for laboratory analysis of VOCs and selected metals;
- Three rounds of water level measurements were collected using the groundwater monitoring wells. This information was used to determine groundwater flow directions across the site with seasonal water level fluctuations noted.

The geophysical logging of an existing on-site water supply well was deleted from the scope of work. The geophysical log was proposed as a method to determine the depth to the confining clay layer separating the water table aquifer and the underlying semi-confined aquifer. This information was needed for the design and installation of the groundwater monitoring wells. The geophysical log became unnecessary since the needed information was obtained through additional research in existing data sources, and through discussions with the subcontracted well installation firm. The well installation firm used for the groundwater monitoring well installations, Moody's of Dayton, is a local business with many years of experience in the Dayton area and is familiar with drilling conditions in and near the site.

Slug testing of the groundwater monitoring wells was attempted, but provided minimal information. The aquifer conditions as encountered in both the unconfined and semi-confined aquifers (extreme permeability) made the slug testing of minimal use as a means of determining representative aquifer characteristics. The slug test findings are included in the report but will not be used in the overall analysis of site conditions.

Section 2.0 - Soil Vapor Survey

The initial field task for the site investigation was the completion of a facility-wide soil vapor survey. The objectives of the soil vapor survey were to:

- Determine the areal extent of contamination by VOCs in the vadose zone;
- Confirm soil vapor survey results from a previous site investigation noting any correlation between elevated readings and potential sources of contaminants;
- Provide a basis for placement of soil borings and groundwater monitoring wells;
- Provide a qualitative evaluation of the potential of using soil venting to remediate vadose zone soils.

2.1 - Sampling and Laboratory Methods

On October 9, 1994 Clean Tech mobilized on-site to begin the soil vapor survey of the site. A Work Plan had been prepared (dated August, 1994) and submitted to Chrysler prior to mobilization. A total of thirty (30) soil vapor sample locations were proposed in the Work Plan. Soil vapor samples were to have been collected from three to eight feet below the ground surface at each location using a hydraulic hammer. The Clean Tech mobile laboratory was also mobilized on-site to provide accurate lab-quality data and rapid analysis of the collected samples.

Clean Tech altered the work plan through the use of a truck mounted Geoprobe subsurface sampling rig. The Geoprobe unit was utilized in order to collect more samples and to provide a better use of manpower and the mobile laboratory. The Geoprobe unit is capable of sampling at greater depths and more quickly than a hydraulic hammer.

The Geoprobe unit was mobilized to sample soil locations on October 10, 1994. The Geoprobe unit drives and withdraws a soil vapor sampling probe. By using Geoprobe, Clean Tech was able to collect soil vapor samples at multiple depths at each location. This

soil vapor survey method generated data which assisted in the understanding of the soil vapor contaminant distribution in the vadose zone.

Geoprobe equipment consists of a truck mounted hydraulic probe unit which drives four foot long sections of hollow metal pipe into the subsurface. The metal pipe is approximately one inch in diameter. A new drive point was used for each location. After the metal pipe was driven to the selected depth, Teflon tubing was inserted through the metal pipe and the surface connections were sealed to prevent the entry of atmospheric air. The probe was then extracted approximately one foot to create an open space at the bottom of the driven hole from which a soil vapor sample was collected.

Approximately fifteen to twenty liters of air were evacuated from the open space at the bottom of each driven hole prior to sample collection using a vacuum pump. A vacuum of approximately fifteen to twenty inches of mercury was applied through the Teflon tubing, and a soil vapor sample of approximately five ml was collected in a gas syringe or Tedlar bag. The sample was immediately brought to the Clean Tech mobile laboratory on-site and directly injected into the gas chromatograph (GC).

All samples were analyzed the same day they were collected. Analysis of the soil vapor samples was performed using modified EPA Method 601. The method detection level was 2.0 parts per billion (ppb).

Sample integrity was maintained through quality control procedures completed prior to, during and after sampling and analysis. New Teflon tubing was used for each sample then discarded. All soil vapor sampling equipment in contact with the sample or subsurface was decontaminated using analconox solution (non-phosphate detergent) followed by a deionized water rinse. Decontamination protocol originally included a methanol rinse but this was found to cause interference in the GC. The use of methanol was therefore discontinued after the first day.

The GC calibration procedures included a system blank and performance of an external calibration curve using known analyte standards at the start of each day prior to analysis of any samples. Ambient air samples were periodically collected during each day through the soil vapor probe, and analyzed to ensure the effectiveness of decontamination procedures. One ambient air blank was analyzed following collection and analysis of every ten soil vapor samples.

Duplicate soil vapor samples were also analyzed as a quality assurance/quality control measure. One duplicate sample was analyzed following collection and analysis of every twenty soil vapor samples. GC calibration was performed at the end of each day following completion of the analysis of all soil vapor samples using a system blank.

2.2 - Sampling Locations

A total of 86 soil vapor samples were collected for analysis from 44 locations across the DTPP property. Daily quality checks of data allowed continuous quality control as the soil vapor survey progressed. Two soil vapor samples, one shallow sample and one deep sample, were collected (or attempted) at each sampling location. The shallow soil vapor sample was collected from approximately ten feet below local grade. The deep soil vapor sample was collected from approximately twenty feet below local grade. Groundwater was typically encountered approximately twenty-five feet below grade. The soil probe occasionally met refusal when advanced, or encountered groundwater shallower than twenty feet, causing an adjustment in sampling depth. The actual sampling depths with a description of each sample location are included in Attachment B (see Volume II of this report).

Soil vapor samples from locations 1 through 20 were collected and analyzed as a reconnaissance sampling effort focused in the eastern and central portions of the facility. The sample locations were relatively closely spaced in the eastern and central portions of the property as can be seen in Drawing 1 (Site Plan) and Drawing 2 (Sample Locations 1

through 48). All drawings are contained in Volume II of this report. These initial soil vapor sample locations served to highlight those areas where focused soil vapor sample collection would provide the best data for accurate determination of contaminant distribution across the entire facility.

The initial samples from locations 1 through 20 were not directly incorporated as contoured data in the soil vapor isoconcentration maps (Drawings 3 through 10) because the data collected from locations 21 through 48 (a total of 49 samples collected from 25 locations) provided good areal coverage of the property. The reconnaissance data and the contoured data qualitatively agreed and in many instances were quite closely spaced in portions of the site. This situation provided both an internal quality check of the data used in the isoconcentration maps, and guidance in establishing the contoured pattern for the data. The soil vapor survey results including: sample numbers, sample locations, sample depths, and the amounts of detected compounds are presented in Attachment C (see Volume II of this report).

2.3 - Findings

The laboratory analysis determined that there were primarily eight volatile organic compounds present in the soil vapor samples, as had been identified in previous investigations. These compounds are listed below with the number of shallow and deep soil vapor samples found to contain the compound above the method detection level. Refer to Attachment C for a summary of the soil vapor results.

Target Compound	Shallow Samples (10")	Deep Samples (20")
1,1,1-trichloroethane (TCA)	16	17
tetrachloroethene (PCE)	22	23
vinyl chloride	14	16
1,1-dichloroethene	1	2
cis-1,2-dichloroethene	3	10
1,2-dichloroethane	5	7

Target Compound	Shallow Samples (10')	Deep Samples (20')
1,1,2-trichloroethane	5	6
1,1-dichloroethane	0	0

Eight isoconcentration contour maps were generated for the soil vapor survey findings based on the available data. Maps were prepared showing: Total VOCs (the sum of all eight compounds), TCA, PCE and vinyl chloride for the shallow soil vapor data, and for the deep soil vapor data. These maps are included as Drawings 3 through 10.

2.3.1 - Contaminant Distribution Patterns

The distribution patterns were examined for each mapped contaminant as they were presented through the isoconcentration contour maps. Shallow and deep vadose zone distribution patterns were developed. These patterns of contaminant distribution were described as follows.

Total VOCs - Shallow Vadose Zone - Drawing 3

The isoconcentration map for total VOCs in the shallow vadose zone was contoured using 50 ppb and 100 ppb contours. The isoconcentration map shows elevated levels of total VOCs were detected in the following areas:

- Within the northern portion of Buildings 40A and 40B, and in the paved area immediately northeast of those buildings;
- In the area of the former TCA tank south of Building 53;
- To the north and east of Building 59;
- In the area near Building 47 extending eastward toward the boiler house;
- In the area north of the boiler house and northeast of Building 47;
- In an isolated area south of Building 59 and west of Building 3A;
- In an isolated area northeast of the wastewater treatment plant.

Total VOCs - Deep Vadose Zone - Drawing 4

The isoconcentration map for total VOCs in the deep vadose zone was contoured using 50 ppb, 100 ppb, and 1,000 ppb contours. The isoconcentration map shows elevated levels of total VOCs were detected in the following areas:

- Within the northern portion of Buildings 40A and 40B, and in the paved area immediately northeast of those buildings;
- In the area of the former TCA tank south of Buildings 50 and 53;
- To the north of Building 59 extending across the vicinity of Building 47;
- In an isolated area south of Building 59 and west of Building 3A;
- In an isolated area south of Building 40 and 40A along Leo Street.

TCA - Shallow Vadose Zone - Drawing 5

The isoconcentration map for TCA in the shallow vadose zone was contoured using 50 ppb and 100 ppb contours. The isoconcentration map shows elevated levels of TCA were detected in the following areas:

- Within the northern portion of Building 40A and in the paved area immediately northeast of that building;
- In the area of the former TCA tank south of Buildings 50 and 53;
- To the south of Building 47 near the waste storage area.

TCA - Deep Vadose Zone - Drawing 6

The isoconcentration map for TCA in the deep vadose zone was contoured using 50 ppb, 100 ppb, and 1,000 ppb contours. The isoconcentration map shows elevated levels of TCA were detected in the following areas:

- Within the northern portion of Building 40A and in the paved area immediately northeast of that building;

- In the area of the former TCA tank south of Buildings 50 and 53;
- In an area extending from north of Building 59 across the south of Building 47 near the waste storage area, and extending to the east near the boiler house.

PCE - Shallow Vadose Zone - Drawing 7

The isoconcentration map for PCE in the shallow vadose zone was contoured using 50 ppb, and 100 ppb contours. The isoconcentration map shows elevated levels of PCE were detected in the following areas:

- In an isolated area south of Building 59 and west of Building 3A;
- Within the northern portion of Building 40A and in the paved area immediately northeast of that building and south of Building 50.

PCE - Deep Vadose Zone - Drawing 8

The isoconcentration map for PCE in the deep vadose zone was contoured using 50 ppb, 100 ppb, and 1,000 ppb contours. The isoconcentration map shows elevated levels of PCE were detected in the following areas:

- In an isolated area south of Building 40 and 40A along Leo Street;
- In the area of the former TCA tank south of Buildings 50 and 53;
- In an isolated area south of Building 59 and west of Building 3A;
- In an area immediately to the north of Building 47;
- Within the northern portion of Building 40A and in the paved area immediately northeast of that building extending north of Building 59.

Vinyl Chloride - Shallow Vadose Zone - Drawing 9

The isoconcentration map for vinyl chloride in the shallow vadose zone was contoured using 50 ppb and 100 ppb contours. The isoconcentration map shows elevated levels of vinyl chloride were detected in the following areas:

- In an isolated area south of Building 59 and west of Building 3A;
- In an isolated area immediately to the southeast of Building 47.

Vinyl Chloride - Deep Vadose Zone - Drawing 10

The isoconcentration map for vinyl chloride in the deep vadose zone was contoured using 50 ppb and 100 ppb contours. The isoconcentration map shows elevated levels of vinyl chloride were detected in the area immediately west of Building 47 near the waste storage area.

2.4 - Discussion

The soil vapor survey revealed the following patterns of contamination in the vadose zone across the DTPP property:

- VOC contamination levels in the vadose zone appear to be greatest in the central portion of the facility in the area to the north of Buildings 40A and 40B, and to the south of Buildings 50 and 53 (former TCA tank area). This pattern was found in both the shallow and deep portions of the vadose zone;
- VOC contamination in the vadose zone was noted at a lesser magnitude yet extends across a larger portion of the facility from north of Building 59 to the area of Building 47 and the associated waste storage area. This pattern was noted for both the shallow and deep portions of the vadose zone, but is much more pronounced in the deep vadose zone;
- Isolated areas of significantly elevated VOCs were noted in the southern portion of the site to the west of Building 3A and south of Building 59, and in the area to the south of Buildings 40 and 40A. This pattern was noted for both the shallow and deep portions of the vadose zone, but was found to be much more pronounced in the deep vadose zone;

- Larger amounts of VOC contamination with greater areal extent of VOC contamination were noted in the deep vadose zone as compared to the shallow vadose zone.

These findings are in close agreement with the work completed during previous soil investigations at the DTPP facility. The areas near Buildings 40A and 40B, the area to the south of Building 53 near the former TCA tanks, the area east of Building 50, and the western and southern portions of the former Maxwell Complex are identified as areas where elevated levels of VOCs may be expected in vadose zone soils.

The soil vapor survey permitted identification of recognizable areas of the DTPP property having a particular pattern of VOC contamination in the vadose zone. These areas were evaluated and are presented as reference areas for discussion of a working model of the site conditions. This model is presented for use in discussions of soil and groundwater contamination patterns, and identification of potential contamination sources. Refer to Figure 3 (see Volume II of this report) for a map of the facility showing these areas.

Area A

Area A was characterized as the central portion of the facility in the area to the north of Buildings 40A and 40B, and to the south of Buildings 50 and 53 (former TCA tank area). Area A exhibits a pattern of significantly elevated levels of total VOCs, TCA and PCE in both the shallow and deep portions of the vadose zone.

Area B

Area B was characterized as the east-central portion of the facility from the northern limit of Building 59 northward across the area of Building 47 and the associated waste storage area. Overall VOC contamination in the vadose zone appeared at a lesser magnitude in Area B than in Area A, but extended across a larger portion of the property in Area B. VOC contamination in Area B was noted for both the shallow and deep portions of the vadose zone, but was found to be more pronounced in the deep vadose zone. Area B

exhibits a pattern of significantly elevated levels of total VOCs in both the shallow and deep vadose zones, TCA in the deep vadose zone, and PCE in the deep vadose zone.

Area C

Area C was characterized as isolated areas of significantly elevated VOCs in the southern portion of the site to the west of Building 3A, south of Building 59, and south of Buildings 40 and 40A. Area C exhibited a pattern of significantly elevated levels of total VOCs and PCE in both the shallow and deep portions of the vadose zone, with elevated levels of vinyl chloride in the shallow vadose zone to the west of Building 3A. VOC contamination was noted for both the shallow and deep portions of the vadose zone, but was much more pronounced in the deep vadose zone.

Significantly elevated levels of VOCs in the deep vadose zone across the property in close proximity to the local water table clearly suggested groundwater contamination may have occurred. The soil vapor survey results provided a guide for placement of the soil borings and groundwater monitoring wells, and a qualitative evaluation showing the potential exists for using soil venting to remediate vadose zone soils.

Section 3.0 - Soil Borings

The purpose of the soil borings was to observe and describe site stratigraphy, sample the vadose soil zone and analyze soils for the contaminants of concern, and determine the extent of contaminated soils in the vadose zone at the site. The selection of the soil boring locations, creation of a work plan for soil sample collection, and the selection of the target analytes for laboratory analysis was based on the review of available information, and information received from Chrysler Corporation environmental staff.

The results of previous investigations indicated vadose zone soils have been impacted by TCE, TCA, PCE and some heavy metal contamination (chromium and lead). The areas which may have been impacted include:

- Building 40B in the area of the former Freon-113 degreaser station;
- South side of Building 53 in the area of the former TCA storage tanks;
- Buildings 40A and 40B which contained former parts degreasers;
- West and southwest of the former Maxwell Complex or present Building 59;
- Storage areas located east of Building 50.

3.1 - Soil Boring Locations

The selection of the soil boring locations was based on the results of the previous investigations, existing information sources, and current soil vapor survey information which served as guidance for boring placement and selection of depth intervals for sampling. Drilling locations were also dependent on access restrictions due to operations of the facility, and underground and above ground utilities. Existing utilities were located and marked by Chrysler personnel. All drilling locations were pre-approved by appropriate DTPP personnel who assured each location was at least ten feet from underground utilities or structures, and that a twenty-foot minimum distance was maintained from above ground utilities.

The soil vapor survey proved a valuable guide to achieving optimum placement of the soil borings. Three areas were defined through the soil vapor survey which displayed patterns of shallow and deep vadose zone contamination by organic compounds. Refer to Figure 3 for a map of the facility showing these areas. Area A was characterized as the central portion of the facility which consists of an area to the north of Buildings 40A and 40B, and to the south of Buildings 50 and 53 (former TCA tank area). Area B was characterized as the east-central portion of the facility from the northern limit of Building 59 northward across the area of Building 47 and the associated waste storage area. Area C was characterized as isolated areas of significantly elevated VOCs in the southern portion of the site to the west of Building 3A, south of Building 59, and south of Buildings 40 and 40A.

On October 17, 1994 Clean Tech mobilized on-site to begin the soil boring installations. A Work Plan and site-specific Health and Safety Plan (HASP) were prepared and submitted to Chrysler Corporation's environmental activities staff prior to the start of drilling. Ten (10) soil borings were proposed and installed at the site.

Soil borings 3, 4, 6 and 8 were placed in Area A, soil borings 1, 2, 5 and 7 were placed in Area B, and soil borings 9 and 10 were placed in Area C. Drawing 11 shows the locations of the soil borings and the areas of contamination defined through the soil vapor survey.

3.2 - Installation Methods

The soil borings were installed using the hollow stem auger drilling method. Drilling was performed by Moody's of Dayton, a local business with many years of drilling experience in the Dayton area, and familiar with subsurface conditions in and near the site. Each borehole was advanced using a CME 75 truck mounted hollow stem auger drilling rig. All soil borings were completed using 4.25" diameter I.D. augers. The soil borings were each advanced to the water table, which was typically encountered at approximately 25 to 30

feet below ground surface (BGS). Soil samples were collected at five foot intervals as each boring was advanced using a standard penetration test with split spoon sampler. The general procedures for drilling and soil sampling activities are presented in Attachment D (see Volume II of this report).

Each soil sample was tested using a hydrophobic dye for the presence of non-aqueous phase liquid. This was a qualitative screening test performed in the field at the time the sample was collected which could detect both light (LNAPL) and dense non-aqueous phase liquids (DNAPL) if present.

Field personnel maintained a field logbook with documentation of all pertinent information about field activities and samples, including sample identification information as included on the sample labels and chain of custody forms. Entries in the logbook were made in ink and included a description of field activities; names of project individuals; date, time, and any field measurement information.

A geologic log was generated for each soil boring. These logs included the depth of the boring, sampled intervals, sample identification and sample recovery, standard penetration test results (blow counts), descriptions of the samples, air monitoring measurements for the breathing zone, borehole and split spoon samples, and the results of the dye test for non-aqueous phase liquids. The geologic logs for the ten soil borings are included as Attachment E (see Volume II of this report).

3.2.1 - Waste Disposal Methods

The installation of the soil borings generated soil cuttings as waste materials. A total of ten soil borings were installed as per the Work Plan. The soil cuttings were placed in drums, labeled and staged on-site. A total of 143 drums of soil cuttings were generated during the combined soil boring and well installation activities.

As described in the Work Plan, the drilling cuttings generated during the soil boring installations were screened for organic vapor emissions using a PID. No free phase product was observed in any of the drilling cuttings. No organic vapor readings were measured which exceeded the action level of 50 ppm described in the HASP for any of the borings. The laboratory analytical results for the soil samples collected from the soil borings do not show significantly elevated levels of VOCs for any of the soil samples. Based on these findings, Chrysler Corporation will move the drummed soil cuttings to an area of the facility near the existing soil stock piles, and spread and grade the soil level on the ground surface as soon as possible.

3.3 - Soil Sampling and Analysis Methods

The soil samples collected from the soil borings were examined in the field, and laboratory analyzed for targeted chemical analysis, and geotechnical evaluation of the subsurface materials. A generalized guide to soil sample depth selection was based on the soil vapor survey.

For soil borings located near the center of areas of elevated soil vapor measurements, a sample was collected for chemical analysis from the split spoon sample having the highest observed PID readings. For soil borings located near the edge of areas of elevated soil vapor measurements, a sample was collected for chemical analysis from the split spoon sample below any elevated PID readings, or at the top of the water table, whichever was encountered first as the boring was advanced.

Geotechnical analysis was performed as an aid to identify applicable remedial technologies for the vadose zone. The geotechnical samples were selected as representative samples of the subsurface materials encountered, and at depths in the borings where an engineered remedial technology might be applied to the vadose zone.

3.3.1 - Chemical Analysis

Chemical analysis of soil samples from the soil borings consisted of quantitative field analysis using the photoionization detector, qualitative field analysis using hydrophobic dye, and laboratory analysis for volatile organic compounds, total organic carbon and metals.

Photoionization Detector

The soil samples were analyzed immediately upon opening the split spoon sampler using an HNu photoionization detector. The PID measured the levels of total volatile organic compounds and reported those measurements as parts per million (ppm) equivalent of the calibration gas, isobutylene. Results typically ranged from background (BG as reported in the geologic logs) for ambient air levels, to under 10 ppm total volatile organic compounds for the majority of the samples. Those samples with measured PID values of 10 ppm or greater are listed below:

Boring	Depth	PID	Comment
SB-3	14-16 ft	10 ppm	Sample approximately 10 ft above water table.
SB-5	19-21 ft	10 ppm	Sample approximately 5 ft above water table.
SB-5	29-31 ft	10 ppm	Sample approximately 5 ft below water table.
SB-7	14-16 ft	10 ppm	Sample approximately 10 ft above water table.
SB-9	19-21 ft	15 ppm	Sample approximately 5 ft above water table.
SB-10	29-31 ft	15 ppm	Sample approximately 5 ft below water table.

Field Analysis Dye Test

The hydrophobic dye test was performed using each sample collected. The results are summarized below for those samples yielding positive dye test results. All other soil boring samples yielded negative results for the dye test.

Boring	Depth	Comment
SB-5	29-31 ft	Sample approximately 5 feet below water table. PID slightly elevated at 10 ppm in sample.
SB-9	19-21 ft	Sample approximately 5 feet above water table. PID slightly elevated at 15 ppm in sample.

Laboratory Analysis

One soil sample from each soil boring was collected and analyzed for the Target Compound List (TCL) volatile organic compounds (VOCs), and the Target Analyte List (TAL) metals. The TCL VOCs list includes 69 targeted organic compounds. Analysis was performed using EPA Method 8260. The TAL metals list includes 18 targeted metals. Analysis was performed using EPA Methods 6010/7000 and 7421 (lead by furnace). Metals analysis was performed as follows:

- ICP analysis for aluminum, barium, beryllium, cadmium, calcium, chromium (total), cobalt, copper, silver, sodium, vanadium, and zinc;
- Furnace analysis for antimony, arsenic lead, selenium, and thallium;
- Mercury analysis by cold vapor.

These lists provide a selection of targeted analytes which might be present based on the available information. One soil sample was collected and analyzed for total organic carbon (TOC) using EPA Method 9060. This was done as a preliminary design step to assist with the determination of possible remedial technologies. The sample collected for TOC analysis was selected as representative of the subsurface materials encountered. Soil samples collected for laboratory analysis are listed below:

Boring	Depth	Analysis Performed
SB-1	9-11 ft	TCL VOCs, TAL Metals
SB-2	19-21 ft	TCL VOCs, TAL Metals
SB-3	14-16 ft	TCL VOCs, TAL Metals
SB-4	14-16 ft	TCL VOCs, TAL Metals, TOC
SB-5	29-31 ft	TCL VOCs, TAL Metals
SB-6	14-16 ft	TCL VOCs, TAL Metals
SB-7	24-26 ft	TCL VOCs, TAL Metals
SB-8	24-26 ft	TCL VOCs, TAL Metals
SB-9	19-21 ft	TCL VOCs, TAL Metals
SB-10	29-31 ft	TCL VOCs, TAL Metals

Quality Assurance and Quality Control

The Quality Assurance/Quality Control (QA/QC) program for chemical analysis of soil samples (both for the soil borings and groundwater monitoring wells) consisted of the collection and analysis of duplicate samples, spiked samples, and equipment blanks. The purpose of this program was to ensure the analyses performed by the analytical laboratory are reproducible. The chain of custody documentation, any QA/QC sample analytical results and the laboratory results for the soil boring samples are included as Attachment F (see Volume III of this report). The QA/QC program for chemical analysis of soil samples is included as Attachment G (see Volume II of this report).

3.3.2 - Geotechnical Analysis

Geotechnical analysis of selected soil samples was performed as an aid in determining applicable remedial technologies. Samples were selected for geotechnical analysis based on their representativeness of the subsurface materials encountered, and at a depth in the boring where an applicable remedial technology might be applied.

The Work Plan submitted to Chrysler proposed a total of six soil samples to be collected from the soil borings for geotechnical analysis. These samples were to have been collected

from the vadose zone and analyzed for particle-size distribution, porosity, permeability, and percent moisture.

The Work Plan was altered in response to site conditions as encountered during the initial phase of drilling. The coarse granular nature of the subsurface materials precluded the planned use of large (three-inch O.D.) split spoons for collection of the geotechnical samples. Minimal sample could be retained in the large split spoon sampler. Additionally, any soil samples collected using a split spoon were so disturbed as to make porosity and permeability measurements less than reliable, regardless of the size or type of sampler used.

Geotechnical samples were collected from the soil borings using a two-inch O.D. split spoon sampler. The soil samples were collected in clean glassware and submitted to Tetra Tech Richardson of Newark, Delaware for textural gradation analysis and percent moisture content. Soil samples collected from the soil borings for laboratory analysis are listed below:

Boring	Depth	Analysis Performed
SB-1	14-16 ft	% Moisture
SB-2	14-16 ft	% Moisture
SB-3	19-21 ft	% Moisture
SB-5	14-16 ft	Textural Gradation, % Moisture
SB-6	19-21 ft	Textural Gradation, % Moisture
SB-10	14-16 ft	Textural Gradation, % Moisture

Quality Assurance and Quality Control

The Quality Assurance/Quality Control (QA/QC) program for geotechnical analysis of soil samples (both the soil borings and the groundwater monitoring wells) specified laboratory test procedures which followed ASTM procedures or approved equivalent methods for analysis of textural gradation and percent moisture. The QA/QC program for geotechnical analysis of soil samples is included as Attachment G (see Volume II of this report). The

results of the geotechnical analysis for the samples collected from the soil borings are included as Attachment H (see Volume III of this report).

Section 4.0 - Groundwater Monitoring Wells

The groundwater monitoring wells were installed to satisfy two objectives. One objective of the groundwater monitoring wells, similar to the soil borings, was to observe and describe site stratigraphy, sample the vadose soil zone for laboratory analysis, and determine the extent of contaminated soils in the vadose zone at the site. The selection of the well locations and soil sampling depths was augmented by the soil boring information as well as previous site investigations, existing information sources and the soil vapor survey findings.

The other objective of the groundwater monitoring wells was to install a total of fifteen wells, twelve in the unconfined aquifer and three in the semi-confined aquifer, which would allow groundwater samples and water-level measurements to be obtained at points across the site in the unconfined and semi-confined aquifers. A total of three well pairs, each pair having one well screened in the unconfined aquifer and one well screened in the semi-confined aquifer, were installed to assess vertical hydraulic gradients at the site.

4.1 - Groundwater Monitoring Well Locations

The selection of the monitoring well locations was completed using the results of the previous site investigations, existing information sources, and the findings of the soil vapor survey and soil borings. This information guided well placement and selection of depth intervals for soil sampling.

Drilling locations were also dependent on access restrictions due to operations of the facility, and underground and above ground utilities. Existing utilities were located and marked by Chrysler personnel. All drilling locations were pre-approved by appropriate DTPP personnel who confirmed each location was at least ten feet from underground utilities or structures, and that a twenty-foot minimum distance was maintained from above ground utilities.

On October 17, 1994 Clean Tech mobilized on-site to begin installation of the groundwater monitoring wells. A Work Plan and site-specific Health and Safety Plan (HASP) were prepared and submitted to Chrysler prior to the start of drilling. A total of fifteen monitoring wells were proposed and installed at the site. Twelve wells were installed in the unconfined aquifer and three wells were installed in the semi-confined aquifer. The wells installed in the unconfined aquifer were installed in two depth ranges within the aquifer. This was done to assess the unconfined aquifer for the possible presence of DNAPLs.

Wells designated MWA were installed in the upper portion of the saturated zone. Total depths for these wells range from 39 to 45 feet BGS, approximately 15 feet below the top of the saturated zone (water table). Wells designated MWB were installed in the lower portion of the saturated zone. Total depths range from 54 to 90 feet BGS. Wells designated MWC were installed in the semi-confined aquifer as paired wells with MWB wells. The total depths for the MWC wells range from 84 to 122 feet BGS. The MWC wells were installed in the upper portion of the semi-confined aquifer.

Three areas were identified and delineated through the soil vapor survey which displayed patterns of shallow and deep vadose zone contamination by organic compounds. Refer to Figure 3 for the locations of these areas. Area A was characterized as the central portion of the facility in the area to the north of Buildings 40A and 40B, and to the south of Buildings 50 and 53 (former TCA tank area). Area B was characterized as the east-central portion of the facility from the northern limit of Building 59 northward across the area of Building 47 and the associated waste storage area. Area C was characterized as isolated areas of significantly elevated VOCs in the southern portion of the site to the west of Building 3A, south of Building 59, and south of Buildings 40 and 40A.

Groundwater monitoring wells MWA-2, MWA-3 and MWB-6 were placed in Area A, wells MWA-1, MWA-5, MWB-2 and MWC-2 were placed in Area B, and wells MWA-4,

MWB-3 and MWC-3 were placed in Area C. Groundwater monitoring wells MWA-6, MWB-1, MWB-4, MWB-5 and MWC-1 were located near the property boundary corners and separated from the identified contaminant areas. This provided coverage of the site as a whole, allowed determination of background water quality for groundwater flowing on to the site, and made data collection possible in additional areas of potential contamination. Drawing 12 shows the locations of the groundwater monitoring wells and the areas of contamination defined through the soil vapor survey.

4.2 - Installation Methods

The shallow groundwater monitoring wells in the unconfined aquifer were installed using the hollow stem auger drilling method. The deeper wells in the semi-confined aquifer were installed using the cable tool drilling method. Drilling was performed by Moody's of Dayton, a local business with many years of drilling experience in the Dayton area.

Soil samples were collected at five-foot intervals as each hollow stem auger boring was advanced using a standard penetration test with split spoon sampler. Soil samples were examined from the cable tool rig when the boring was bailed, and split spoon samples were collected from the confining unit (till layer) and from the portion of the semi-confined aquifer where the well screen was set. The general procedures for drilling and soil sampling activities are presented in Attachment D (see Volume II of this report).

Each soil sample was tested using a hydrophobic dye for the presence of non-aqueous phase liquid. This was a qualitative screening test performed in the field at the time the sample was collected which could detect both light (LNAPL) and dense non-aqueous phase liquids (DNAPL) if present.

Field personnel maintained a field logbook with documentation of all pertinent information about field activities and samples, including sample identification information as included on the sample labels and chain of custody forms. Entries in the logbook were made in ink

and included a description of field activities; names of individuals involved; date, time, and any field measurement information.

A geologic log was generated for each groundwater monitoring well. These logs include: the depth of the boring, sampled intervals, sample identification, sample recovery, standard penetration test results (blow counts), descriptions of the samples, air monitoring measurements for the breathing zone, borehole and split spoon samples, the results of the dye test for non-aqueous phase liquids, and well construction details. The geologic logs for the groundwater monitoring wells are included as Attachment I (see Volume II of this report).

Unconfined Aquifer Wells

A total of twelve wells were installed in the unconfined aquifer in two depth ranges. This was done to assess the shallow and deeper portions of the unconfined aquifer for both dissolved phase contaminants and the presence of DNAPLs. Analytical results at the Gem City, Inc. site immediately east of DTPP indicated higher VOC concentrations were present in the shallow portion of the unconfined aquifer.

Wells designated MWA were installed in the shallow portion of the saturated zone. Total depths for these wells range from 39 to 45 feet BGS, approximately 15 feet below the top of the saturated zone (water table). The water table is anticipated to fluctuate between ten and fifteen feet during the year. Wells designated MWB were installed in the deeper portion of the saturated zone immediately above the confining layer (till layer). Total depths range from 54 to 90 feet BGS. MWB-4 was completed at a more shallow depth (35 feet) due to conditions encountered during well installation.

Each shallow well boring was advanced using a CME 75 truck mounted hollow stem auger drilling rig. The borings were completed using 4.25" or 6.25" diameter I.D. augers.

The larger augers were used whenever site conditions allowed. Soil sampling was performed using procedures as presented in Attachment D.

Each well was constructed inside the hollow stem augers using two-inch diameter PVC casing and ten feet of 10 slot two-inch diameter PVC well screen. After insertion of the casing and screen, sand pack (Global Filter Pack #5) was poured to approximately two feet above the top of the well screen as the augers were withdrawn. An approximately three-foot thick bentonite seal was installed above the sand pack. The bentonite seal was allowed to hydrate and expand prior to placement of the grout. The remaining annular space was grouted using a positive pressure tremmie pipe. Care was taken to avoid disturbing the bentonite seal during grout placement. The grout mixture was allowed to cure before installation of flush mounted locking well covers.

Semi-Confined Aquifer Wells

Three groundwater monitoring wells were installed targeting the semi-confined aquifer below the confining layer (till layer). These wells were designated MWC as presented in the geologic logs (see Attachment I). MWC-1 was double-cased, and MWC-2 and MWC-3 were triple-cased to prevent groundwater migration between the unconfined aquifer and the semi-confined aquifer. The borings for the semi-confined aquifer wells were advanced using a BE22-W cable tool drilling rig.

The boring for MWC-1 was advanced and eight-inch diameter steel casing was driven through the unconfined aquifer to approximately five feet below the top of the till layer. The till consisted of clay with variable amounts of sand and gravel. The boring was then advanced through the till layer and a split spoon sample of the till was collected from two feet below the top of the till layer for lithologic description. Split spoon samples of the semi-confined aquifer were collected from the interval to be screened for lithologic description, and six-inch diameter steel casing was installed to the total depth of 112 feet BGS.

The MWC-1 well was constructed inside the six-inch casing using two-inch diameter PVC casing and ten feet of 10 slot two-inch diameter PVC well screen. The well screen was set from 102 to 112 feet BGS. The top of the well screen was positioned approximately six feet below the base of the till layer. After insertion of the casing and screen, sand pack (Global Filter Pack #5) was poured to approximately two feet above the top of the well screen as the six-inch casing was withdrawn from the boring. An approximately three-foot thick bentonite seal was installed above the sand pack. The bentonite seal was allowed to hydrate and expand prior to placement of the grout. The remaining annular space was grouted using a positive pressure tremmie pipe. Care was taken to avoid disturbing the bentonite seal during grout placement. The grout mixture was allowed to cure before installation of a flush mounted locking well cover.

The boring for MWC-2 was advanced and twelve-inch diameter steel casing was driven through the unconfined aquifer to approximately two feet below the top of the till layer where it was grouted in place. A split spoon sample of the till was collected from two to four feet below the top of the till layer for lithologic description. The boring was then advanced into the till layer and eight-inch diameter steel casing was driven to approximately eight feet below the top of the till layer where it was grouted in place. The boring was advanced through the till layer, and split spoon samples of the semi-confined aquifer were collected from the interval to be screened for lithologic description. Six-inch diameter steel casing was installed to the total depth of 122 feet BGS.

The MWC-2 well was constructed inside the six-inch casing using two-inch diameter PVC casing and ten feet of 10 slot two-inch diameter PVC well screen. The well screen was set from 112 to 122 feet BGS. The top of the well screen was positioned approximately ten feet below the base of the till layer. After insertion of the casing and screen, sand pack (Global Filter Pack #5) was poured to approximately two feet above the top of the well screen as the six-inch casing was withdrawn. The six-inch casing was withdrawn to nineteen feet above the top of the screen (into the till layer) where it jammed and was grouted in place. An approximately three-foot thick bentonite seal was installed above the

sand pack. The bentonite seal was allowed to hydrate and expand prior to placement of the grout. The remaining annular space was grouted using a positive pressure tremmie pipe. Care was taken to avoid disturbing the bentonite seal during grout placement. The grout mixture was allowed to cure before installation of a flush mounted locking well cover.

The boring for MWC-3 was advanced and twelve-inch diameter steel casing was driven through the unconfined aquifer to approximately two feet below the top of the till layer where it was grouted in place. A split spoon sample of the till was collected from two to four feet below the top of the till layer for lithologic description. The boring was then advanced into the till layer and eight-inch diameter steel casing was driven to approximately four feet below the top of the till layer where it was grouted in place. The boring was advanced through the till layer, and split spoon samples of the semi-confined aquifer were collected in the interval to be screened. Six-inch diameter steel casing was installed to the total depth of 84 feet BGS.

The MWC-3 well was constructed inside the six-inch casing using two-inch diameter PVC casing and ten feet of 10 slot two-inch diameter PVC well screen. The well screen was set from 74 to 84 feet BGS. The top of the well screen was positioned approximately five feet below the base of the till layer. After insertion of the casing and screen, sand pack (Global Filter Pack #5) was poured to approximately two feet above the top of the well screen as the six-inch casing was withdrawn from the boring. An approximately three-foot thick bentonite seal was installed above the sand pack. The bentonite seal was allowed to hydrate and expand prior to placement of the grout. The remaining annular space was grouted using a positive pressure tremmie pipe. Care was taken to avoid disturbing the bentonite seal during grout placement. The grout mixture was allowed to cure before installation of a flush mounted locking well cover.

Soil sampling for the semi-confined aquifer wells was performed following the procedures presented in Attachment D.

Well Development

Each monitoring well was developed after installation to restore the natural hydraulic properties of the aquifer and facilitate free hydraulic connection between the aquifer and the well. Well development was performed by surging the screened interval and pumping the well. Field measurements were collected including conductivity, pH, and temperature. Water turbidity was monitored.

Each well was developed until the measured parameters stabilized, and the water pumped from the well was relatively turbidity-free. The wells were each developed for a period of approximately thirty to sixty minutes. Approximately 200 to 350 gallons of water were pumped from each well during the development process.

4.2.1 - Waste Disposal Methods

The installation and sampling of the groundwater monitoring wells generated soil cuttings and groundwater as waste materials. A total of fifteen groundwater monitoring wells were installed and sampled as per the Work Plan. The soil cuttings were placed in drums, labeled and staged on site. A total of 143 drums of soil cuttings were generated during the combined soil boring and well installation activities.

A total of approximately 3,630 gallons of water were pumped from the wells during the well development process. Additionally, the wells were each purged of at least three wellbore volumes of water prior to the collection of each round of groundwater samples producing a total of approximately 525 gallons of purge water.

Soil Cuttings

As described in the Work Plan, the drilling cuttings were screened for organic vapor emissions using a PID. No free phase product was observed in any of the drilling cuttings. No organic vapor readings were measured for the breathing zone or borehole which

exceeded the action level of 50 ppm as described in the HASP for any of the wells. The laboratory analytical results for the soil samples do not show significantly elevated levels of VOCs for any of the soil samples. Based on these findings, Chrysler Corporation will move the drummed soil cuttings to an area of the facility near the existing soil stock piles, and spread and grade the soil level on the ground surface as soon as possible.

Water

As described in the Work Plan, drilling fluids, well development water, purge water, and decontamination fluids generated by field investigation activities were screened for organic vapor emissions using the PID. No free phase product was observed in any of the produced water, however, organic vapor readings from these fluids were occasionally found to exceed the action level of 50 ppm as described in the HASP. Therefore, in accordance with the Work Plan, all drilling fluids, well development water, and decontamination fluids were temporarily containerized at the well head and transferred to the on-site wastewater treatment plant for final disposal at the time of well installation and development.

Purge water generated during purging of the wells prior to collection of both rounds of groundwater samples was drummed and staged at the well head. The laboratory analytical results for the groundwater samples do not show significantly elevated levels of VOCs for any of the groundwater samples. No free phase product was observed in any of the produced water, however, organic vapor readings from the purge water as measured during the first round of groundwater sampling were occasionally found to exceed the action level of 50 ppm as described in the HASP. Therefore, in accordance with the Work Plan, Chrysler Corporation will move all of the drummed purge water to the on-site wastewater treatment plant for final disposal as soon as possible.

4.3 - Soil Sampling and Analysis Methods

The soil samples collected from the groundwater monitoring wells were examined in the field, and laboratory analyzed for targeted chemical analysis and geotechnical evaluation of the subsurface materials. A generalized guide to soil sample depth selection was formed based on the soil vapor survey, and the site conditions encountered during the soil boring installations.

For wells located near the center of areas of elevated soil vapor measurements, a soil sample was collected from the split spoon sample having the highest observed PID readings. For wells located near the edge of areas of elevated soil vapor measurements, a soil sample was collected from the split spoon sample below any elevated PID readings or at the top of the water table, whichever was encountered first as the boring was advanced.

4.3.1 - Chemical Analysis

Chemical analysis of the soil samples from the groundwater monitoring wells consisted of quantitative field analysis using the photoionization detector, qualitative field analysis using hydrophobic dye, and laboratory analysis for volatile organic compounds, total organic carbon and metals.

Photoionization Detector

The soil samples were analyzed immediately upon opening the split spoon sampler using an HNu photoionization detector. The PID measured the levels of total volatile organic compounds and reported those measurements as parts per million equivalent of the calibration gas, isobutylene. Results typically ranged from background (BG as reported in the geologic logs) for ambient air levels to under 10 ppm total volatile organic compounds for the majority of the samples. Those samples with measured PID values of 10 ppm or greater are listed below:

Well	Depth	PID	Comment
MWA-1	19-21 ft	10 ppm	Sample approximately 5 ft above water table.
MWA-1	24-26 ft	10 ppm	Sample approximately 1 ft above water table.
MWA-1	34-36 ft	15 ppm	Sample approximately 10 ft below water table.
MWA-2	14-16 ft	10 ppm	Sample approximately 10 ft above water table.
MWA-2	19-21 ft	12 ppm	Sample approximately 5 ft above water table.
MWA-3	24-26 ft	12 ppm	Sample approximately 5 ft below water table.
MWA-3	29-31 ft	70 ppm	Sample approximately 3 ft below water table.
MWA-3	34-36 ft	70 ppm	Sample approximately 8 ft below water table.
MWA-4	19-21 ft	50 ppm	Sample approximately 5 ft above water table.
MWA-4	24-26 ft	75 ppm	Sample approximately at water table.
MWA-4	29-31 ft	80 ppm	Sample approximately 5 ft below water table.
MWA-4	34-36 ft	80 ppm	Sample approximately 10 ft below water table.
MWA-4	39-41 ft	100 ppm	Sample approximately 15 ft below water table.
MWA-4	44-46 ft	60 ppm	Sample approximately 20 ft below water table.
MWB-3	34-36 ft	15 ppm	Sample approximately 8 ft below water table.
MWB-3	44-46 ft	20 ppm	Sample approximately 18 ft below water table.
MWB-6	24-26 ft	14 ppm	Sample approximately at water table.

Field Analysis Dye Test

The hydrophobic dye test was performed using each sample collected. The results are summarized below for those samples yielding positive dye test results, suggesting the presence of non-aqueous phase liquids. All other soil samples from the groundwater monitoring wells yielded negative results for the dye test.

Well	Depth	Comment
MWA-4	24-26 ft	Sample approximately at water table. PID elevated at 75 ppm in sample.
MWB-1	69-71 ft	Sample approximately 50 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	64-66 ft	Sample approximately 40 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	69-71 ft	Sample approximately 45 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	74-76 ft	Sample approximately 50 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	79-81 ft	Sample approximately 55 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	84-86 ft	Sample approximately 60 feet below water table. Possible natural oil from overlying clay unit.
MWB-2	89-91 ft	Sample approximately 65 feet below water table. Possible natural oil from overlying clay unit.
MWB-3	39-41 ft	Sample approximately 15 feet below water table. Possible natural oil from underlying clay unit.
MWB-3	54-56 ft	Sample approximately 30 feet below water table. Possible natural oil from underlying clay unit.
MWB-5	39-41 ft	Sample approximately 10 feet below water table. Possible natural oil from clay unit.
MWB-5	49-51 ft	Sample approximately 20 feet below water table. Possible natural oil from clay unit.
MWB-5	54-56 ft	Sample approximately 25 feet below water table. Possible natural oil from clay unit.
MWB-5	59-61 ft	Sample approximately 30 feet below water table. Possible natural oil from clay unit.
MWB-5	64-66 ft	Sample approximately 35 feet below water table. Possible natural oil from clay unit.
MWB-5	67-71 ft	Sample approximately 40 feet below water table. Possible natural oil from clay unit.
MWB-5	74-76 ft	Sample approximately 45 feet below water table. Possible natural oil from clay unit.
MWB-5	79-81 ft	Sample approximately 50 feet below water table. Possible natural oil from clay unit.
MWB-5	84-86 ft	Sample approximately 55 feet below water table. Possible natural oil from clay unit.
MWB-5	89-91 ft	Sample approximately 60 feet below water table. Possible natural oil from clay unit.
MWB-6	39-41 ft	Sample approximately 15 feet below water table. Possible natural oil from underlying clay unit.
MWB-6	44-46 ft	Sample approximately 20 feet below water table. Possible natural oil this clay unit.

Laboratory Analysis

Soil samples were collected from the monitoring well borings and analyzed for TCL VOCs, and TAL metals. The TCL VOC list analysis was performed using EPA Method

8260. The TAL Metals list analysis was performed using EPA Methods 6010/7000 and 7421 (lead by furnace). Metals analysis was performed as follows:

- ICP analysis for aluminum, barium, beryllium, cadmium, calcium, chromium (total), cobalt, copper, silver, sodium, vanadium, and zinc;
- Furnace analysis for antimony, arsenic lead, selenium, and thallium;
- Mercury analysis by cold vapor.

Four soil samples were collected and analyzed for total organic carbon (TOC) using EPA Method 9060. The samples collected for TOC analysis were selected as representative of the subsurface materials encountered. Soil samples collected for laboratory analysis are listed below:

Well	Depth	Analysis Performed
MWA-1	24-26 ft	TCL VOCs, TAL Metals
MWA-2	19-21 ft	TCL VOCs, TAL Metals
MWA-3	24-26 ft	TCL VOCs, TAL Metals
MWA-4	24-26 ft	TCL VOCs, TAL Metals
MWA-5	24-26 ft	TCL VOCs, TAL Metals
MWA-6	24-26 ft	TCL VOCs, TAL Metals
MWB-1	49-51 ft	TOC
MWB-2	24-26 ft	TCL VOCs, TAL Metals
MWB-3	24-26 ft	TCL VOCs, TAL Metals, TOC
MWB-4	19-21 ft	TCL VOCs, TAL Metals, TOC
MWB-5	24-26 ft	TCL VOCs, TAL Metals, TOC
MWB-6	24-26 ft	TCL VOCs, TAL Metals

Quality Assurance and Quality Control

The Quality Assurance/Quality Control (QA/QC) program for chemical analysis of soil samples (both for the soil borings and the groundwater monitoring wells) consisted of the collection and analysis of duplicate samples, spiked samples, and equipment blanks. The purpose of this program was to ensure the analyses performed by the analytical laboratory

are reproducible. The chain of custody documentation, any QA/QC sample analytical results and the laboratory results for the soil samples collected from the groundwater monitoring wells are included as Attachment J (see Volume III of this report). The QA/QC program for chemical analysis of soil samples is included as Attachment G (see Volume II of this report).

4.3.2 - Geotechnical Analysis

Geotechnical analysis of selected soil samples was performed to assist with the identification of possible remedial technologies. Samples were selected for geotechnical analysis based on their representativeness of the subsurface materials encountered, and at a depth in the boring where a possible remedial technology might be applied.

The Work Plan submitted to Chrysler proposed a total of six soil samples to be collected from the soil borings only. None were to have been collected from the monitoring well borings. Samples were to have been collected from the vadose zone and analyzed for particle-size distribution, porosity, permeability, and percent moisture. Three Shelby tube samples were to have been collected from the confining layer (till layer) during installation of the wells in the semi-confined aquifer. The Shelby tube samples were to have been analyzed for permeability using a constant head permeability test for granular soils.

The Work Plan was altered in response to site conditions encountered during drilling. The coarse granular nature of the subsurface materials precluded the planned use of large (three-inch O.D.) split spoons for collection of the geotechnical samples. Any soil samples collected using a split spoon were found to be so disturbed as to make porosity and permeability measurements less than reliable. Representatives of the well drilling firm, Moody's of Dayton, reported that their previous experiences attempting Shelby tube samples in the till layer were unsuccessful. Shelby tubes typically crush when pushed into the stiff clay and gravel of the till. If a Shelby tube was crushed in a boring advanced using the cable tool drilling method, there is no reliable way to recover it. The boring

would then need to be grouted and abandoned, and the well installation started again.

Geotechnical samples were collected from the monitoring well borings using either a two-inch or three-inch O.D. split spoon sampler. The soil samples were collected in clean glassware and submitted to Tetra Tech Richardson of Newark, Delaware for textural gradation analysis. Soil samples collected from the groundwater monitoring well borings are listed below:

Well	Depth	Analysis Performed
MWA-4	39-41 ft	Textural Gradation
MWA-5	34-36 ft	Textural Gradation
MWB-2	74-76 ft	Textural Gradation
MWC-1	104-106 ft	Textural Gradation
MWC-2	114-116 ft	Textural Gradation
MWC-3	76-78 ft	Textural Gradation

Quality Assurance and Quality Control

The Quality Assurance/Quality Control (QA/QC) program for geotechnical analysis of soil samples (both the soil borings and the groundwater monitoring wells) specified laboratory test procedures which followed ASTM procedures or approved equivalent methods for textural gradation analysis. The results of the geotechnical analysis are included as Attachment K (see Volume III of this report). The QA/QC program for geotechnical analysis of soil samples is included as Attachment G (see Volume II of this report).

4.4 - Groundwater Sampling and Analysis Methods

Groundwater samples were collected from each of the fifteen groundwater monitoring wells during two sampling events. The wells were sampled twice to determine if there are any effects on water quality due to seasonal water level fluctuations. The first sampling event was completed in December, 1994 and the second was completed in February,

1995. Both groundwater sampling events were performed using Clean Tech's standard sampling procedures.

Groundwater samples were collected and analyzed for TCL VOCs and TAL metals. Chromium analysis was performed using total chromium as the target analyte. Chromium VI analysis was not performed for the groundwater samples because the sample holding times were in excess of 24 hours.

Each well remained static for approximately two weeks following well development to allow the portion of the aquifer disturbed during the well installations to equilibrate. All wells were screened for evidence of organic vapors prior to collection of the first round of groundwater samples in December 1994 using a PID. The PID was inserted into the open well top immediately upon opening the well. The PID measurement was recorded in the field logbook. The wells were not screened for evidence of organic vapors at the time of the second round of groundwater samples in February 1995 because the ambient air temperature was so low during that time as to render the PID ineffective as an air monitoring tool. Water levels were measured from the top of the PVC casing prior to well purging. An interface probe was used to measure water levels and the thickness of any non-aqueous phase product (LNAPL or DNAPL) prior to purging the well in preparation for groundwater sampling. The water levels and notes regarding any non-aqueous phase product were recorded for both sampling rounds.

All wells were purged prior to sample collection to obtain a representative groundwater sample. Each well was purged of at least three wellbore volumes of water prior to sample collection. The groundwater sample collection procedures are presented in Attachment L (see Volume II of this report).

Quality Assurance and Quality Control

The Quality Assurance/Quality Control (QA/QC) program for chemical analysis of groundwater consisted of the collection and analysis of duplicate samples, and equipment

and trip blanks. The purpose of this program was to ensure the analyses performed by the analytical laboratory are reproducible. The chain of custody documentation, any QA/QC sample analytical results and the laboratory results for the groundwater samples are included as Attachment M (Round #1) and Attachment N (Round #2), and are presented in Volume III of this report. The QA/QC program for chemical analysis of groundwater samples is included as Attachment O (see Volume II of this report).

4.4.1 - Water Level Measurements

Water level measurements were collected at each groundwater monitoring well on a monthly basis for a period of three months after completion of the wells. Three rounds of water level measurements were collected to observe temporal variations in groundwater levels during the reporting period. The depth to water in each monitoring well was measured from the top of the PVC well casing. The PVC well casing tops were surveyed for each monitoring well and referenced to a standard elevation, thereby allowing computation of the reference elevation for the water level in each well.

All soil borings and monitoring well tops (top of PVC casing) were surveyed for vertical and horizontal control by a State of Ohio licensed surveyor. The survey was performed using a site specific local coordinate system for horizontal control which tied surveyed traverses to the on site buildings, and a United States Geologic Survey benchmark located at the intersection of Webster and Leo Street for vertical control referenced to feet above mean sea level. Elevations were measured to the nearest 0.01 foot.

Water-level measurements were obtained at the time of the first groundwater sampling event on December 13-14, 1994, on January 24, 1995, and at the time of the second groundwater sampling event on February 20, 1995. Water level measurements were collected from each monitoring well prior to the beginning of purging and groundwater sample collection. Piezometric surface maps for the unconfined aquifer are included as Drawings 22, 23, and 24. All Drawings are included in Volume II of this report.

The water level measurements were collected using the following procedure. All sampling team members wore new and clean disposable gloves during measurements at each well to protect team members from exposure to potentially contaminated groundwater, and to minimize the potential for cross-contamination between wells. The lock was removed from the locking well cap just prior to measuring. While standing upwind, the well cap was removed and the well was allowed to vent. The permanent measurement reference point was then located on the PVC well casing.

The decontaminated two-phase interface probe was lowered into the well to the static water level. The well was inspected for the presence of any LNAPL which might be presence as a layer on top of the static water level. No LNAPL layers were detected in any wells during any of the three water level measurement events. The monitoring well number and the distance from the permanent reference point to the static water level were recorded to the nearest 0.01 foot in the bound log book. The static water elevation was computed and recorded in the bound log book. This value is the elevation of the measured reference point minus the depth to the water in the well.

The interface probe was then lowered to the bottom of the well to inspect the well for the possible presence of a DNAPL layer (a different audible signal will sound if the interface probe contacts a non-water fluid). No DNAPL was detected in any well during any of the three water level measurement events. The elevation of the bottom of the well was computed and recorded in the bound log book. This value is the elevation of the measured reference point minus the depth to the bottom of the well. The two-phase interface probe was then removed from the well, and decontaminated. The measurement tape and probe were wiped along its entire length, discarding and replacing the towels as they became soiled. Field decontamination of the interface probe was accomplished by washing the instrument using a phosphate-free detergent followed by a potable water rinse. The equipment was then rinsed using deionized water and allowed to air dry.

Section 5.0 - Geology

The geology of the Chrysler DTPP facility is discussed as a means of understanding the nature of the subsurface and its influence on potential contaminant migration pathways. The discussion of the regional geology of the Dayton area provides a reference framework. It was prepared from published reports and available site investigations obtained for nearby properties. The site geology was further examined through information gathered during installation of the soil borings and groundwater monitoring wells, with additional information obtained from the records of the water supply wells located on the property.

5.1 - Regional Geology

The regional geology of the Dayton, Ohio area has been examined and discussed by several authors. Original publications by Norris, (1959), and Walton and Scudder, (1960) were reviewed. Site investigations by QSource Engineering, Inc., (1993) for the Gem City Chemicals, Inc. facility, and by Mathes & Associates, (1991) for the DTPP property incorporate these and several additional previous studies. The regional geology of the area has been summarized here from these information sources.

The regional geologic setting of the Dayton, Ohio area consists of glacial and glacial-fluvial (outwash stream) sediments deposited over an irregular bedrock surface. Highly permeable calcareous sands and gravel fill pre-glacial or glacial valleys eroded into the underlying bedrock. These permeable glacial deposits are believed to be outwash deposits originating from retreating glaciers. The permeable deposits have formed shallow and deeper aquifers separated by low permeability confining layers. The confining layers are till layers composed primarily of clay with mixtures of gravel, sand, and silt.

The bedrock underlying the glacial sediments is believed to consist of relatively impermeable materials. It is mapped as the Ordovician Richmond Group, and is thought to

be composed of soft, light gray, calcareous shale with interbedded layers of limestone. Few wells in the region have reached the bedrock surface, which is estimated to be 250 to 300 feet BGS in most areas. The bedrock yields little to no water, provides little recharge to the overlying aquifers, and acts as an impervious lower and lateral boundary to the overlying aquifers.

Regional studies of the glacial and glacial-fluvial deposits have shown the uppermost recognizable geologic unit is a sand and gravel outwash deposit approximately 80 feet thick. This unit is typically recognized as the unconfined aquifer. Discontinuous till layers have been encountered within this unit at depths between 40 and 50 feet BGS.

The unconfined aquifer is generally underlain by a till layer present at approximately 80 feet BGS. This till layer appears to be laterally persistent, but may be absent from some locations in the region due either to non-deposition or erosion. Till layers have been reported as massive clay units, or as zones of alternating clay with stratified sand and gravel. Till layers act as confining layers which control aquifer recharge and regional groundwater flow.

Till layers are known to contain significant amounts of natural hydrocarbons. The well drillers were quick to recognize the natural hydrocarbon as it was encountered in clays within the unconfined aquifer, and from the till underlying the unconfined aquifer. The hydrocarbon was a dark brown liquid found as a non-aqueous phase product. It was noted in drilling cuttings, when bailing during cable tool drilling, and during examination of soil samples. The State of Ohio Geological Survey was consulted regarding the hydrocarbon and confirmed the hydrocarbon is a natural material found throughout the region. The Survey noted a major oil company had recently studied the viability of hydrocarbon production from till layers in the region.

Regional studies indicate that a second recognizable sand and gravel outwash deposit underlies the till layer found at approximately 80 feet BGS. This lower aquifer behaves as

a confined or semi-confined aquifer. However, if the till layer is thin or absent the hydraulically connected sand and gravel units act as a single unconfined aquifer.

Deep wells in the region suggest discontinuous till layers may exist within the second glacial outwash unit (the semi-confined aquifer), and additional semi-confined or confined aquifers exist at greater depths. These deeper aquifers are believed to be separated by till layers in much the same way as the shallower geologic units. Deeper aquifers were not examined in this investigation.

5.2 - Site Geology

The site geology was examined through information gathered during installation of the soil borings and groundwater monitoring wells, with additional information obtained from the records of the production wells located on the property. Refer to Drawings 11 and 12 for locations of the soil borings and monitoring wells in Volume II of this report. Refer to Attachments E and I (see Volume II of this report) for geologic logs containing descriptions of the materials found in the soil borings and monitoring wells. Geologic cross-sections were prepared using the information contained in the boring logs, specifically differentiating the subsurface units containing significant amounts of clay from the more permeable gravel and sand units. A map showing the locations of the geologic cross-sections is included as Figure 4, and the three geologic cross-sections are included as Drawings 25, 26, and 27 in Volume II of this report.

The site geology as determined from information obtained from the borings and wells consists primarily of sand and gravel with minor amounts of silt and clay. These are the glacial and glacial-fluvial sediments typical of the region. The sand and gravel is interbedded with till and clay layers composed of massive clay units, or zones of clay with sand and gravel. The uppermost two to four feet is typically a disturbed clay-bearing material which is absent in many places, probably due to site development activities. None of the borings or wells reached the bedrock surface.

The uppermost geologic unit at the site is a sand and gravel outwash deposit approximately 75 to 90 feet thick. This is the unconfined aquifer. Clay units, and units composed of clay, sand and gravel mixtures were encountered within the unconfined aquifer. Several of these units are laterally persistent suggesting they might exert some local control over potential contaminant migration pathways. Additional clay-bearing units were noted in the unconfined aquifer, but were restricted to certain small areas of the site. The more laterally persistent clay-bearing units within the unconfined aquifer are summarized as follow:

Clay Units Within the Unconfined Aquifer

Depth of Clay-Bearing Unit	Well or Boring Encountering Clay-Bearing Unit
4-6 ft	SB-1, SB-6 (to 11' BGS), SB-9, MWA-5, MWA-6, MWB-1 (to 16' BGS), MWB-4 (to 16' BGS), MWB-5
19-21 ft	SB-2 (to 26' BGS), SB-8, SB-10 (to 26' BGS), MWA-3, MWA-4, MWA-5 (to 26' BGS), MWB-3, MWC-3
29-31 ft	SB-4, SB-6, SB-10, MWB-6, Production Well #4
34-75 ft	MWB-4
39- 41 ft	MWA-2, MWA-3, MWB-2 (to 51')
64 ft -	MWB-1 (to 76' BGS), MWB-2 (to 81' BGS), MWB-5 (to 90' BGS)

A persistent till layer was encountered which was interpreted as forming the confining layer between the unconfined aquifer and the underlying semi-confined aquifer. The thickness of the till was 20 feet in MWC-1, 23 feet in MWC-2, 14 feet in MWC-3, 15 feet in Production Well #3, and 25 feet in Production Well #4. The approximate depth to the top of the till layer as seen in the deeper wells is listed below:

Depth to Confining Layer at Base of Unconfined Aquifer

Well	Depth to Till at Base Unconfined Aquifer
MWB-1, MWC-1	76 feet BGS
MWB-2, MWC-2	85 to 89 feet BGS
MWB-3, MWC-3	56 to 57 feet BGS
MWB-5	90 feet BGS
MWB-6	44 feet BGS
Production Well #3	85 feet BGS
Production Well #4	80 feet BGS

The semi-confined aquifer was encountered below the till layer in MWC-1, MWC-2, and in Production Wells #3 and #4. It consists of sand and gravel with minor amounts of fine-grained material, much like the unconfined aquifer. These materials are glacial and glacial-fluvial sediments typical of the region. The monitoring wells penetrated approximately 20 feet of the uppermost portion of the unit. No clay-bearing units were noted in the portion of the semi-confined aquifer examined. Drillers logs for Production Wells #3 and #4 describe the unit as coarse grained sand and gravel. A till layer was encountered in Production Well #3 between 128 and 129 feet BGS.

Section 6.0 - Hydrogeology

The hydrogeology of the Chrysler DTPP facility is presented to gain an understanding of potential subsurface contaminant transport mechanisms. Groundwater flow behavior and aquifer properties form the hydraulic framework for an understanding of the documented pattern of contamination at the site. Regional and site hydrogeology are discussed.

6.1 - Regional Hydrogeology

The regional hydrogeology of the Dayton area has been discussed by several authors. Original publications by Norris, (1959), and Walton and Scudder, (1960) were reviewed, along with site investigations by QSource Engineering, Inc., (1993) for the Gem City Chemicals, Inc. facility, and by Mathes & Associates, (1991) and Clean Tech, (1994) for the subject property.

The regional geologic setting of the Dayton, Ohio area consists of highly permeable calcareous sands and gravel deposited in pre-glacial or glacial valleys eroded into the underlying bedrock. These glacial deposits form shallow and deeper aquifers separated by low permeability confining layers (glacial till) composed primarily of clay with mixtures of gravel, sand, and silt. The bedrock materials are of low permeability and act to form lateral and lower boundaries to the flow of groundwater through the permeable materials.

Regional studies of the permeable deposits have shown the uppermost recognizable hydrogeologic unit is a sand and gravel deposit approximately 80 feet thick which is recognized as the unconfined aquifer. Discontinuous till layers have been encountered within this unit which act as local confining layers. The hydraulic conductivity of the shallow aquifer is approximately 200 feet per day with a transmissivity reported to be approximately 15,000 to 40,000 square feet per day (QSource Engineering, Inc.).

Studies completed by Dames & Moore in 1991, and reviewed by Clean Tech, 1994 for the DAP site which is located about four miles north of this site, included an aquifer recovery test which monitored drawdown in the monitoring wells and piezometers surrounding the pumping well. Transmissivity values in the range of 249,000 gallons per day per foot to 747,000 gallons per day per foot were reported. The transmissivity appears to generally be lower in the shallow part of the aquifer and increases with depth.

The lithology of the deeper aquifer is very similar to the shallow aquifer. Based on reports prepared for Gem City Chemicals, the saturated thickness of the deep aquifer is approximately 60 feet thick. Hydraulic conductivity values range from 140 to 200 feet per day. Reported transmissivity ranges from 1,200 to 12,000 square feet per day. The reported storage coefficient of 0.001 is within the expected range for a confined aquifer.

Values for the aquifer parameters developed by CH₂M Hill for the development of the Miami South Well Field were reviewed by Clean Tech, 1994:

Upper Aquifer

Hydraulic Conductivity	-	0.003 ft/sec (260 ft/day, 2021 GPD/ft ²)
Storativity	-	0.2 ft/ft

Till Layers

Hydraulic Conductivity	-	0.44×10^{-6} ft/sec (0.04 ft/day, 0.3 GPD/ft ²)
Storativity	-	0 ft/ft

Lower Aquifer

Hydraulic Conductivity	-	0.001 ft/sec (87 ft/day, 710 GPD/ft ²)
Storativity	-	0.00001 ft/ft

The analysis assumed a 50 foot thick saturated zone in the upper aquifer, and variable thickness for the till and lower aquifer. The transmissivity values were not calculated

directly. All values were calculated assuming that each of the layers were homogeneous and isotropic. Due to the directions of flow that were calculated, the calculated hydraulic conductivities are likely to reflect the horizontal conductivity in the "upper" and "lower" aquifers, and the vertical conductivity through the till. Considerable local variability from these values is likely across the region.

During the pump test conducted at Gem City Chemicals, Inc. on February 21, 1990, the recovery well was pumped at a rate of 340 gpm and the water level in the piezometer installed 3.5 feet away from the pumping well was monitored. The drawdown was 0.75 feet after 450 minutes of pumping. This gives a reported value for transmissivity of 52,900 square feet per day or 395,000 gallons per day per foot, and a hydraulic conductivity of 0.226 centimeters per second (755 ft/day). This value is about three times the average value calculated from the regional studies.

Based on these values, the pre-pumping groundwater flow velocity was estimated to be about 1.2 feet per day. The current flow velocity in the area surrounding the pumping well is estimated to be 6.4 feet per day. The potentiometric surface elevations have been measured in the two well clusters located at the northeastern and southwestern limits of Gem City Chemicals, Inc. The levels measured in the three wells in each cluster are similar, which indicated that the groundwater flow is nearly level at both locations.

Due to the presence of the till layer separating the valley fill deposits into "upper" and "lower" aquifer systems, the direction of groundwater flow was evaluated separately at Gem City Chemicals for each of the two layers. As described previously, a low-permeability till layer is present beneath Gem City Chemicals, Inc. and for at least one-half mile surrounding the site. This till layer effectively isolates the uppermost, unconfined aquifer at Gem City Chemicals, Inc. from deeper confined aquifers.

Ground-water flow directions in the lower aquifer have changed considerably during the past thirty years, due to changes in water usage in the surrounding areas. Clean Tech,

1994 reported that potentiometric maps compiled by Norris & Spiker for 1959 and 1960 (prior to the time when the Miami South Well Field began operations) show groundwater flow to the southwest, toward a wide cone of depression developed beneath the central business district of Dayton, and also toward industrial facility water supply wells to the southwest. A major cone of depression developed beneath the South Miami Well Field following the beginning of water production from the well field in the early 1960's. Maps compiled by CH₂M Hill for 1972 show this cone of depression. The location of Gem City Chemicals, Inc. appeared to be on or near a groundwater divide between these two cones of depression, and the direction of groundwater flow at the DTPP site was thought to be either to the north or to the south, or it could fluctuate depending on recharge variations and variability in the pumping rates at the city's well field.

In August of 1988, the City of Dayton adopted a Well Field Protection Program to protect its drinking water supplies. The southern limit of the Miami Well Field Protection Overlay District is Stanley Avenue, which borders the DTPP property. Well yields for wells within the area as published in Norris & Spiker (1966) range from 20 gallons per minute (No. 209) to a maximum of 1,000 gallons per minute (No. 212), as reported by Clean Tech, 1994. A test well in the South Miami Well Field pumped at a rate of 2,283 gallons per minute. The City's Mad River Well Field is approximately two miles to the east of the site and does not receive any recharge from this area as reported by QSource Engineering.

The unconfined aquifer has been widely utilized as a water source throughout the region. The main source of groundwater recharge to the unconfined aquifer is infiltration from local rivers. Direct recharge by precipitation, and recharge by subsurface flow from the edges of buried valleys provide lesser amounts of recharge to the aquifer. Available annual precipitation is higher during the months of March through June in the Dayton region.

Wells constructed in portions of the aquifer having a substantial saturated thickness may yield up to 1,000 gallons per minute (gpm) for a short period of time, although yields of

100 gpm to 500 gpm are more common. The presence of thick layers of till within the aquifer has been shown to decrease these short-term yields up to 50%. Areas having thin deposits of sand and gravel, such as locations near the edges of the buried valleys, have been shown to yield substantially less water.

The unconfined aquifer is generally underlain by a till layer present at approximately 80 feet BGS. This till layer appears to be laterally persistent across areas on the order of a mile, but evidence suggests it may be discontinuous on a larger regional scale across the entire buried valley in the Dayton region. The till has been found to be absent from some locations in the region due either to non-deposition or erosion.

Till layers have been reported as massive clay units, or as zones of alternating clay with stratified sand and gravel. Till has been shown to have low permeability and yields little water to wells. It has been used as a local aquifer for domestic or farm water supply wells (up to 12 gpm) near the edges of the buried valley deposits when sand and gravel content are high within the till.

Till layers generally act as confining layers, controlling aquifer recharge and creating barriers to groundwater flow. Norris examined recharge to the aquifer underlying a regional till layer and found that leakage through the confining layer was responsible for the majority of the groundwater recharge to the lower aquifer. This leakage was not assumed to represent a breach in the till layer, but rather uniform transmission of water through the till under a hydraulic gradient. A leakage coefficient was computed for the till of 0.003 gallons per day per cubic foot.

Regional studies indicate that a second recognizable sand and gravel outwash deposit underlies the till layer found at approximately 80 feet BGS. This lower aquifer behaves as a confined or semi-confined aquifer. However, if the till layer is thin or absent the hydraulically connected sand and gravel units will act as a single unconfined aquifer. This

second recognizable sand and gravel deposit is the semi-confined aquifer examined during this investigation.

The semi-confined aquifer is utilized as a major water source throughout the region for municipal supplies. The main source of groundwater recharge to the semi-confined aquifer is the overlying unconfined aquifer. Wells constructed in the semi-confined aquifer have routinely yielded 2,000 gpm for extended periods of time. Chemical quality of the water from the unconfined and semi-confined aquifers has been shown to be similar by Walton and Scudder, 1960.

Deep wells in the region suggest discontinuous till layers may exist within the second glacial outwash unit (the semi-confined aquifer), and additional semi-confined or confined aquifers exist at greater depths. These deeper aquifers are believed to be separated by till layers in much the same way as the shallower geologic units.

6.2 - Site Hydrogeology

The hydrogeology of the site was examined through information gathered from groundwater monitoring wells, with additional information obtained from the records of the production wells located on the property. The hydrogeology of the site is typical of the region. The permeable subsurface materials consist of glacial and glacial-fluvial sediments made up of sand and gravel with minor amounts of silt. The sand and gravel is interbedded with till and other clay layers composed of massive clay units, or zones of clay with sand and gravel. Two aquifers were examined in this investigation: the shallow unconfined aquifer and the deeper semi-confined aquifer.

Slug Testing

Hydraulic conductivity testing was attempted following collection of the first round of groundwater samples on December 15 and 16, 1994. The planned hydraulic conductivity testing employed slug testing techniques. A slug test consists of causing a water-level

change within a well and measuring the rate at which the water level returns to its initial level. This rate of recovery can be related to the hydraulic conductivity of the surrounding aquifer material.

Approximately one gallon of deionized water was added to the wells. The volume of water added was chosen to displace an equal volume of water equivalent to approximately five feet of standing water in the well. The slug tests were conducted using a digital data logger and pressure transducer. All equipment in contact with the well or groundwater was decontaminated using a solution of ten percent methanol in potable water. The length of the transducer cable and the probe were wiped clean using the methanol solution, discarding and replacing the towel as it became soiled, and rinsed using deionized water.

Slug testing of the groundwater monitoring wells was attempted, but provided minimal information. The aquifer materials encountered in both the unconfined and semi-confined aquifers were recognized to have extreme permeability and porosity when first described during the well and boring installations. Published reports indicate these aquifers can have porosity values up to approximately 35%, and transmissibility of approximately 280,000 gallons per day per foot in the Dayton area. This extreme permeability as encountered at the site made the slug testing method minimally effective as a means of determining representative aquifer characteristics.

6.2.1 - Unconfined Aquifer

The hydrogeology of the unconfined aquifer was investigated through analysis of water level elevations, interpretation of groundwater flow direction and gradients, examination of the relationship between the water level measurements and confining units as encountered in the wells, and the pattern of contamination as observed in the groundwater and soil across the site.

Water Level Elevations, Flow Direction and Gradient

Water level measurements were collected at each groundwater monitoring well on a monthly basis for a period of three months on December 13-14, 1994, on January 24, 1995, and on February 20, 1995. The interpreted direction of groundwater flow was computed for each set of water level measurements as shown in Drawings 22, 23 and 24 presented in Volume II of this report.

The maps show a generally non-uniform groundwater elevation change, producing a variable gradient, across the site from the southwest toward the northeast for the three measurement sets. The gradient near the southwestern portion of the site was approximately 0.0003 feet/foot, and became steeper in the northeastern portion of the site where the gradient was approximately 0.001 feet/foot for all three measurement sets. The groundwater flow gradient appeared to vary across the site for each set of water level measurements, but the amount of variance in the gradient appeared to remain constant between measurement sets.

All January 1995 water elevations fell approximately 0.5 to 1.0 foot in the unconfined aquifer from the December 1994 levels. All February 1995 water elevations fell approximately 0.25 to 0.5 foot in the unconfined aquifer from the January 1995 levels. The interpreted direction of groundwater flow in the unconfined aquifer across the subject site remained toward the northeast for the three sets of water level measurements.

Water Levels and Confining Layers

The direction of groundwater flow potential in the semi-confined aquifer could not be uniquely established because the water elevation levels and pattern of water level fluctuations over time in the MWC-3 well suggest that well appears more similar to the unconfined aquifer wells, that is, the MWC-3 well appears to be hydraulically connected to the unconfined aquifer.

The hydraulic connection of the MWC-3 well with the unconfined aquifer might best be explained by an examination of the configuration of the till layer in that portion of the site. Refer to geologic cross-section A-A' included as Drawing 25 in Volume II of this report. The till layer which is most laterally persistent, and could best be interpreted as the confining layer separating the two aquifers, occurs at approximately 85 to 90 feet BGS. The till encountered at the shallower depth of 57 feet BGS in MWC-3, and at 44 feet BGS in MWB-6 can now be reliably identified as a till layer other than the principal confining till layer separating the aquifers.

The till encountered in MWC-3 and MWB-6 may correlate to one of two clay layers noted in MWB-2 at 39 to 51 feet, or between approximately 64 to 84 feet BGS. These clay units are interpreted to be wholly within the unconfined aquifer. Therefore, these lines of evidence support the conclusion that the MWC-3 well, although completed below a twelve foot thick till layer, is completed in a portion of the unconfined aquifer hydraulically connected to the same sands screened in the MWA and MWB wells. The hydraulic connection between the MWC-3 well and the unconfined aquifer apparently occurs because the till layer seen in the southeastern portion of the site becomes substantially thinner and ceases to be a barrier to flow in the east central portion of the site.

The till layer has apparently protected the portion of the unconfined aquifer below the till layer from encountering significant contamination by organic compounds. The MWB-3 well, completed in the unconfined aquifer above the till layer, was found to have 8612.8 ppb total VOCs in the first round groundwater sample, and 13,727.6 ppb total VOCs in the second round groundwater sample. Both groundwater samples collected from MWC-3 were found to have less than detectable levels of total VOCs.

Contaminant Distribution Patterns

Contaminant distribution patterns were examined for each mapped contaminant. The levels of tetrachloroethylene in the unconfined aquifer appear to be greatest in the central

portion of the facility within Area A and Area B. The levels of trichloroethene in the unconfined aquifer appear to be greatest along the southern portion of the site in Area C.

Contamination is greater in the shallow portion of the unconfined aquifer than the deeper portions of the same aquifer suggesting groundwater in contact with the base of the unsaturated soil zone is in contact with a contamination source, possibly for only a limited period of time during seasonal water level fluctuations. Seasonal water level fluctuations as observed during this investigation appeared to remove groundwater from contacting contaminated soil. As the water level fell during the three month period of this investigation, the overall level of groundwater contamination by VOCs decreased.

The groundwater contamination plumes as shown on the isoconcentration maps conform well to the interpreted groundwater flow direction. The contaminant plumes in Areas A and B appear to originate from locations within the plant. The plume shown in Area C appears to originate either from the portion of the site directly adjacent to Leo Street, or from an off-site source.

Production Well #2, completed in the unconfined aquifer, was the site production well found to contain detectable contamination by organic compounds during preliminary testing of groundwater quality in 1989 and 1990. This well is operational but is not used routinely at this time. The well was pumping tested when installed and found to be suited to operate in the range of 600 to 750 gpm with a specific yield of 30 gpm per foot of drawdown.

6.2.2 - Semi-Confined Aquifer

The semi-confined aquifer was encountered below the till layer in MWC-1, MWC-2, and is shown in records of Production Wells #3 and #4. As previously discussed, the MWC-3 well appears to have been completed in the unconfined aquifer directly below a till layer contained within the unconfined aquifer. The direction of groundwater flow in the semi-

confined aquifer is not clear at this time because only two wells yield reliable water elevations for the semi-confined aquifer.

The semi-confined aquifer consists of sand and gravel with minor amounts of fine-grained material, much like the unconfined aquifer. The monitoring wells penetrated approximately 20 feet of the uppermost portion of the aquifer. No clay-bearing units were noted in the portion of the semi-confined aquifer examined. Drillers logs for Production Wells #3 and #4 describe the unit as coarse grained sand and gravel. A till layer was encountered in Production Well #3 between 128 and 129 feet BGS.

Production Well 3 appears to have been screened in a zone approximately 115 to 135 feet deep in the semi-confined aquifer. A pumping test was not performed, but the well was pumped as much as 1,000 gallons per minute during initial operation and testing. Well 3 was permanently abandoned in 1994 and replaced by Well 4.

Production Well 4 appears to have been screened in a zone approximately 118 to 150 feet deep in the semi-confined aquifer. A pumping test was not performed, but the well was pumped at 614 gallons per minute during initial operation and testing.

Based on the findings of the two groundwater sampling rounds the semi-confined aquifer does not appear to be affected by VOC contamination at this time. No VOCs were detected in any well completed in the semi-confined aquifer in either groundwater sampling round.

6.2.3 - Vertical Flow Potential

The vertical flow potential provides an assessment of the potential for movement of groundwater, and potential contaminants, from one aquifer to another. The available information as compiled during regional hydrogeological analysis, and for the site specific information generated as a part of this investigation indicate the potential exists for

groundwater to move downward from the unconfined aquifer to the semi-confined aquifer.

It has been well established that recharge to the semi-confined aquifer across the region is primarily derived from leakage through the till layer separating the aquifers. A leakage coefficient has been proposed by Norris of 0.003 gallons per day per cubic foot of till. Site water level measurements support this regional relationship. The water levels measured in the MWC-1 and MWC-2 wells were consistently lower than the water levels in the wells completed in the unconfined aquifer. Water levels were 3.5 feet to 5 feet lower in the semi-confined aquifer in the three sets of water level measurements. This head difference between the aquifers indicates that a hydraulic gradient exists between the two aquifers creating the potential for movement of contaminated groundwater from the unconfined aquifer downward into the semi-confined aquifer across the site.

Section 7.0 - Findings and Discussion for Soil Samples

The soil samples collected from the soil borings and the groundwater monitoring wells were examined in the field, and laboratory analyzed for targeted chemical analysis and geotechnical evaluation of the subsurface materials.

7.1 - Chemical Analysis and Findings

Soil samples were collected from each soil boring and groundwater monitoring well boring and analyzed for TCL VOCs and TAL metals. Selected soil samples were collected and analyzed for TOC. The QA/QC program for chemical analysis of the soil samples consisted of the collection and analysis of duplicate samples, spiked samples, and equipment blanks. The chain of custody documentation, any QA/QC sample analytical results and the laboratory results are included as Attachment F for the soil boring samples, and as Attachment J for the soil samples collected from the monitoring well borings, both of which are presented in Volume III of this report. Soil samples collected for laboratory analysis are listed below:

Soil Samples Collected from Soil Borings

Boring	Depth	Analysis Performed
SB-1	9-11 ft	TCL VOCs, TAL Metals
SB-2	19-21 ft	TCL VOCs, TAL Metals
SB-3	14-16 ft	TCL VOCs, TAL Metals
SB-4	14-16 ft	TCL VOCs, TAL Metals, TOC
SB-5	29-31 ft	TCL VOCs, TAL Metals
SB-6	14-16 ft	TCL VOCs, TAL Metals
SB-7	24-26 ft	TCL VOCs, TAL Metals
SB-8	24-26 ft	TCL VOCs, TAL Metals
SB-9	19-21 ft	TCL VOCs, TAL Metals
SB-10	29-31 ft	TCL VOCs, TAL Metals

Soil Samples Collected from Monitoring Well Borings

Well	Depth	Analysis Performed
MWA-1	24-26 ft	TCL VOCs, TAL Metals
MWA-2	19-21 ft	TCL VOCs, TAL Metals
MWA-3	24-26 ft	TCL VOCs, TAL Metals
MWA-4	24-26 ft	TCL VOCs, TAL Metals
MWA-5	24-26 ft	TCL VOCs, TAL Metals
MWA-6	24-26 ft	TCL VOCs, TAL Metals
MWB-1	49-51 ft	TOC
MWB-2	24-26 ft	TCL VOCs, TAL Metals
MWB-3	24-26 ft	TCL VOCs, TAL Metals, TOC
MWB-4	19-21 ft	TCL VOCs, TAL Metals, TOC
MWB-5	24-26 ft	TCL VOCs, TAL Metals, TOC
MWB-6	24-26 ft	TCL VOCs, TAL Metals

Chemical Analysis: VOCs

The laboratory analysis detected a total of twelve volatile organic compounds in the soil samples as listed in the following tables.

Soil VOCs for Soil Boring Samples

VOCs	SB-1 @ 9'	SB-2 @ 19'	SB-3 @ 14'	SB-4 @ 14'	SB-5 @ 29'	SB-6 @ 14'	SB-7 @ 24'	SB-8 @ 24'	SB-9 @ 19'	SB-10 @ 29'
tetrachloroethylene	45	ND	490	14	860	38	280	480	390	ND
trichloroethene	16	ND	75	ND	47	54	20	ND	2600	3100
dichloromethane	ND	ND	ND	ND	ND	37	ND	ND	33	ND
1,2-dichloroethene (total)	ND	ND	ND	ND	ND	ND	ND	ND	15	110
cis-1,2 dichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND	15	110

VOCs in Soil Samples from Soil Borings.

All Results in Parts per Billion (ug/kg).

ND denotes analyte was not detected at the laboratory detection levels.

Soil VOCs for Monitoring Well Boring Samples

VOCs	MWA1 @ 24'	MWA2 @ 19'	MWA3 @ 24'	MWA4 @ 24'	MWA5 @ 24'	MWA6 @ 24'
tetrachloroethylene	5300	1800	260	150	300	ND
trichloroethene	91	200	52	1300	64	90
dichloromethane	26	ND	ND	ND	ND	ND
1,2-dichloroethene(total)	ND	ND	ND	140	ND	ND
cis-1,2 dichloroethene	ND	ND	ND	140	ND	ND
1,1,1-trichloroethane	25	640	160	ND	39	ND
1,2-dichlorobenzene	ND	29	ND	ND	ND	ND
n-butylbenzene	ND	ND	ND	52	ND	ND
sec-butylbenzene	ND	ND	ND	50	ND	ND
n-propylbenzene	ND	ND	ND	28	ND	ND
1,3,5-trimethylbenzene	ND	ND	ND	15	ND	ND

VOCs in Soil Samples from Monitoring Wells.

All Results in Parts per Billion (ug/kg).

ND denotes analyte was not detected at the laboratory detection levels.

Soil VOCs for Monitoring Well Boring Samples

VOCs	MWB2 @ 24'	MWB3 @ 24'	MWB4 @ 19'	MWB4 @ 24'	MWB5 @ 24'	MWB6 @ 24'
tetrachloroethylene	4000	ND	ND	ND	ND	ND
trichloroethene	ND	1200	ND	ND	470	400
dichloromethane	20	15	ND	ND	14	ND
1,2-dichloroethene (total)	ND	81	ND	ND	ND	53
cis-1,2 dichloroethene	ND	81	ND	ND	ND	53
1,1,1-trichloroethane	ND	ND	ND	ND	14	420
1,1-dichloroethane	ND	ND	ND	ND	ND	17

VOCs in Soil Samples from Monitoring Wells.

All Results in Parts per Billion (ug/kg).

ND denotes analyte was not detected at the laboratory detection levels.

Three isoconcentration contour maps were generated which show the interpreted distribution of volatile organic compounds in the soil based on the laboratory results. Maps were prepared for: total VOCs, tetrachloroethylene, and trichloroethene. These maps are included as Drawings 13, 14, and 15 in Volume II of this report.

Total VOCs - Drawing 13

The isoconcentration map for total VOCs was contoured using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb and 5,000 ppb contours. The isoconcentration map shows elevated levels of total VOCs were detected in the soils in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B; in the paved area immediately north and east of those buildings; and in the area of the former TCA tank south of Building 53;
- Area B: to the north of Building 59; in the area near Building 47 extending northward and toward the east; and in the area north of the boiler house and northeast of Building 47;
- Area C: along the southern portion of the site adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40, 40A and 40B.

Tetrachloroethylene - Drawing 14

The isoconcentration map for tetrachloroethylene was contoured using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb and 5,000 ppb contours. The isoconcentration map shows elevated levels of tetrachloroethylene were detected in the soils in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B; in the paved area immediately north of those buildings; and in the area of the former TCA tank south of Building 53;
- Area B: to the north of Building 59; in the area near Building 47 extending northward and toward the east; and in the area north of the boiler house and northeast of Building 47;
- Area C: contamination was noted to a lesser degree than Area A or Area B along the southern portion of the site adjacent to Leo Street south of Buildings 40, 40A and 40B.

Trichloroethene - Drawing 15

The isoconcentration map for trichloroethene was contoured using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb and 5,000 ppb contours. The isoconcentration map shows elevated levels of trichloroethene were detected in the soils in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B; in the paved area immediately north of those buildings; and in the area of the former TCA tank south of Building 53;
- Area B: in the area to the west of Building 47 with contamination noted to a lesser degree than seen in Area A or Area C;
- Area C: along the southern portion of the site adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40, 40A and 40B.

The soil sample results and interpreted distribution of contaminants revealed the following patterns of contamination in the soil across the Chrysler Corporation property:

- The levels of tetrachloroethylene in the soil appear to be greatest in the central portion of the facility within Area A and Area B. The distribution of the tetrachloroethylene controls the total VOCs distribution pattern in this portion of the site. The affected areas are within the northern portion of Buildings 40A and 40B; in the paved area immediately north and east of those buildings; in the area of the former TCA tank south of Building 53; to the north of Building 59; in the area near Building 47 extending northward and toward the east; and in the area north of the boiler house and northeast of Building 47;
- The levels of trichloroethene in the soil appear to be greatest along the southern portion of the site within Area C. The distribution of the trichloroethene controls the total VOCs distribution pattern in this portion of the site. The affected area is adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40, 40A and 40B.

These findings are in agreement with the work completed during previous soil investigations at the facility, and with the soil vapor survey completed as a part of this investigation. The soil vapor survey permitted identification of recognizable areas of the site having a particular pattern of VOC contamination in the vadose zone. These areas (Area A, B, C) were presented as a working model of the site conditions useful in the discussion of soil contamination patterns, and identification of potential contamination sources.

The areas near Buildings 40A and 40B, the area to the south of Building 53 near the former TCA tanks, the area east of Building 50, and the western and southern portions of the former Maxwell Complex are identified as areas where elevated levels of VOCs are present in the soil. Significantly elevated levels of VOCs have been identified in the soil in close proximity to the local water table.

Chemical Analysis: Metals

The laboratory analysis detected the following metals in the soil samples from the soil borings and the monitoring well borings. The results are listed in the following tables.

Soil Metals for Soil Boring Samples

Metals	SB-1 @ 9'	SB-2 @ 19'	SB-3 @ 14'	SB-4 @ 14'	SB-5 @ 29'	SB-6 @ 14'	SB-7 @ 24'	SB-8 @ 24'	SB-9 @ 19'	SB-10 @ 29'
Aluminum	1600	1400	1900	1900	1700	1800	1500	1900	1600	1400
Barium	7.2	12	11	11	12	11	12	11	8	9.6
Beryllium	ND	ND	ND	0.22	ND	ND	ND	ND	ND	ND
Cadmium	0.65	0.63	0.58	0.67	0.53	0.72	0.73	0.47	0.72	0.46
Calcium	140,000	110,000	130,000	260,000	130,000	100,000	140,000	110,000	77,000	70,000
Chromium	7.1	6.9	6.9	5.6	8.7	5	4.5	6.8	5.2	4.8
Cobalt	ND	ND	ND	4.6	ND	ND	ND	ND	ND	ND
Silver	3.9	3.1	3.6	2.7	3.3	3.2	2.8	2.9	3	2.4
Copper	2.2	8.9	8.7	8.7	8	9.7	10	7.2	8.1	8.1
Sodium	280	140	190	200	210	210	180	160	290	140
Vanadium	ND	ND	ND	8.2	ND	ND	ND	ND	ND	ND
Zinc	16	18	20	16	14	17	24	16	19	22
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	4.8	4.3	5.6	3	16	5.4	6.4	6.5	5.2	3
Lead	2	2	2	2	3	2.4	2.5	4.1	1.6	2.8
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	1.2	1.3	0.8	1.7	1.4	1.8	1.2	1.1	1.3	0.94
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Metals in Soil Samples from Soil Borings.

All Results in Parts per Million (mg/kg).

ND denotes analyte was not detected at the laboratory detection levels.

Soil Metals for Monitoring Well Boring Samples

Metals	MWA1 @ 24'	MWA2 @ 19'	MWA3 @ 24'	MWA4 @ 24'	MWA5 @ 24'	MWA6 @ 24'
Aluminum	2300	2300	3300	1900	1800	2300
Barium	12	13	11	15	9	14
Beryllium	0.099	0.21	0.26	ND	0.1	ND
Cadmium	0.3	0.71	0.78	0.66	0.68	0.71
Calcium	93,000	220,000	90,000	100,000	150,000	100,000
Chromium	7.4	9	7.1	6.4	7.9	5
Cobalt	5.7	4.9	4.1	2.6	5.4	2.8
Silver	3.7	2.7	3.3	2.1	4.2	2
Copper	9	9.6	7.3	11	8.7	11
Sodium	140	150	120	140	190	120
Vanadium	9.7	9.6	8.7	5.6	8.7	5.4
Zinc	17	19	20	23	15	19
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	6.5	4.4	5.6	2.6	2.5	4.2
Lead	4	3.2	3.3	3.2	3.5	3
Selenium	ND	ND	ND	ND	ND	ND
Thallium	2	1.9	0.9	0.82	2.6	0.61
Mercury	ND	ND	ND	ND	ND	ND

Metals in Soil Samples from Monitoring Wells. All Results in Parts per Million (mg/kg).

ND denotes analyte was not detected at the laboratory detection levels.

Soil Metals for Monitoring Well Boring Samples

Metals	MWB2 (@ 24')	MWB3 (@ 24')	MWB4 (@ 24')	MWB4 (@ 19')	MWB5 (@ 24')	MWB6 (@ 24')
Aluminum	2100	1500	2000	1900	2100	2900
Barium	12	12	14	13	10	10
Beryllium	0.088	0.3	0.23	0.21	0.27	0.28
Cadmium	0.62	0.68	0.62	0.67	0.55	0.77
Calcium	83,000	140,000	190,000	260,000	73,000	100,000
Chromium	7.2	6.8	6.5	6.2	6.3	7
Cobalt	5.1	8.2	4.4	4.8	8.3	4.4
Silver	3.7	3.1	2.5	2.5	2.7	3.1
Copper	10	12	8.8	9.1	9.1	8.1
Sodium	140	190	160	130	170	130
Vanadium	9.5	9.5	7.4	8.6	11	8
Zinc	22	19	18	18	22	18
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	7.1	6	4.1	4.1	8.4	3.5
Lead	3.5	3	4.6	4.5	3.3	2.6
Selenium	ND	ND	ND	ND	ND	ND
Thallium	2	4.6	1.6	1.6	2.1	0.75
Mercury	ND	ND	ND	ND	ND	ND

Metals in Soil Samples from Monitoring Wells. All Results in Parts per Million (mg/kg).
ND denotes analyte was not detected at the laboratory detection levels.

The detected metal species were compared to the mean concentrations of those metals occurring naturally in soils of the Eastern United States (includes Ohio). This information was compiled by the United States Geological Survey and presented in the 1984 publication Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, Professional Paper 1270, by Shacklette and Boerngen. A summary of this comparison is presented in the following table.

Comparison of Mean Metals Concentration and Sample Concentrations

Metals Species	Concentration Range (# Samples)	Eastern US Mean (Includes Ohio)
Aluminum	1400-2900 ppm (all)	5.7 %
Barium	7.2 - 15.0 ppm (all)	420 ppm
Beryllium	0.099-0.3 ppm (10 of 21)	0.85 ppm
Cadmium	0.3-0.78 ppm (all)	None Given
Calcium	70,000-260,000 ppm (all)	0.65 %
Chromium	4.5-9.0 ppm (all)	52 ppm
Cobalt	2.6-8.3 ppm (12 of 21)	9.2 ppm

Metals Species	Concentration Range (# Samples)	Eastern US Mean (Includes Ohio)
Silver	2.0-4.2 ppm (all)	None Given
Copper	2.2-12.0 ppm (all)	22 ppm
Sodium	120-290 ppm (all)	0.78 %
Vanadium	5.4-11.0 ppm (12 of 21)	66 ppm
Zinc	14-24 ppm (all)	52 ppm
Antimony	All Not Detected	----
Arsenic	2.5-16.0 ppm (all)	7.4 ppm
Lead	1.6-4.6 ppm (all)	17 ppm
Selenium	All Not Detected	----
Thallium	0.61-4.6 ppm (all)	None Given
Mercury	All Not Detected	----

A total of eighteen metals species were targeted for analysis. Three of the targeted metals were below detectable levels in the samples. Thirteen metals were found to be within the Eastern United States mean values for those metals. Two metals were found to be present at levels significantly above the Eastern United States mean values. Calcium was measured in the range between 7 % and 26 % for all the soil samples. This range is well above the Eastern United States mean value of 0.65 %, but within the expected range for calcium in the Dayton, Ohio area because the sands and gravels underlying the area are known to be calcareous sediments, that is, made up of calcium-bearing minerals. Arsenic was measured in the range between 2.5 ppm and 16.0 ppm. The Eastern United States mean value is 7.4 ppm, however, the observed range of naturally occurring arsenic was reported up to 73 ppm for the Eastern United States.

Three metals, cadmium, silver, and thallium, were not assigned mean values in the referenced report. Common ranges for cadmium and silver were compiled by Dragan, 1988 and were compared to the analyzed samples. Cadmium concentrations were between 0.3 and 0.78 ppm for all samples which is within the common range reported for cadmium of 0.01 to 7.0 ppm. Silver concentrations were within the range of 2.0 to 4.2 ppm for all samples which is within the common range reported for silver of 0.1 to 5.0 ppm. Thallium was detected in all samples at concentrations in the range of 0.61 to 4.6 ppm.

Chemical Analysis: TOC

Soil samples were collected and analyzed for TOC. The samples collected for TOC analysis were selected as representative of the subsurface materials encountered. Laboratory results for the TOC analysis are listed below:

Total Organic Carbon in Soil Samples

SB-4 @ 30'	MWB1 @ 49'	MWB3 @ 49'	MWB4 @ 49'	MWB5 @ 49'
35,000	17,000	100	18,000	21,000

TOC in Soil Samples.
All Results in Parts per Million (mg/kg).

Organic carbon typically exists in a variety of oxidation states. Some of these carbon compounds can be oxidized further by biological or chemical processes. TOC provides a direct expression of the total organic content of the sample independent of the oxidation state of the organic matter. TOC does not measure other organically bound elements that can contribute to the total oxygen demand during the oxidation process.

The TOC concentrations in the range of 17,000 to 35,000 ppm indicate significant organic carbon is available to be oxidized further by biological or chemical processes. The relatively low concentration of TOC found in MWB-3 @ 49' indicates relatively little organic carbon is available for biological or chemical oxidation in that sample.

QA/QC

The QA/QC program for chemical analysis of the soil samples consisted of the collection and analysis of duplicate samples, spiked samples, and equipment blank. Two duplicate soil samples were collected and analyzed as was done for all soil samples. MWA-7 is a duplicate sample of MWB-2 from 24'. MWB-7 is a duplicate of MWB-4 from 19'. Soil samples were spiked in the laboratory, analyzed and the results were retained at the laboratory in their records retention system. One equipment blank was collected by pouring deionized water over the decontaminated sampling equipment and collecting the

rinsate for laboratory analysis. The rinsate water sample was identified as MWA-5-24. No VOCs were detected in the equipment blank sample indicating the decontamination of the equipment was thorough and no cross-contaminants were introduced to the samples.

The detected VOCs and targeted metals in the duplicate sample pairs are presented in the following table. Overall reproducibility of the laboratory results between the duplicate samples showed that sample handling did not appear to introduce any significant variability in the results.

Duplicate Soil Sample Pairs

Duplicate Samples	MWB2 @ 24'	MWA7	% Difference	MWB4 @ 19'	MWB7	% Difference
tetrachloroethylene	4000	2600	35	ND	ND	0
1,1,1-trichloroethane	ND	21	>100	ND	ND	0
trichloroethene	ND	38	>100	ND	ND	0
dichloromethane	20	ND	>100	ND	ND	0
Aluminum	2100000	2200000	4	1900000	1800000	5
Barium	12000	13000	7	13000	11000	15
Beryllium	88	95	7	210	190	9
Cadmium	620	750	17	670	630	6
Calcium	83000000	120000000	31	260000000	230000000	11
Chromium	7200	8400	14	6200	5900	5
Cobalt	5100	5800	12	4800	4200	12
Silver	3700	3400	8	2500	3600	31
Copper	10000	11000	9	9100	8400	8
Sodium	140000	150000	7	130000	130000	0
Vanadium	9500	9200	3	8600	7800	9
Zinc	22000	25000	12	18000	16000	11
Antimony	ND	ND	0	ND	ND	0
Arsenic	7100	4000	44	4100	2500	39
Lead	3500	3600	3	4500	3000	33
Selenium	ND	ND	0	ND	ND	0
Thallium	2000	1800	10	1600	1900	16
Mercury	ND	ND	0	ND	ND	0

VOCs detected in Duplicate Soil Samples shown in Parts per Billion (ug/kg),
Metals Targeted in Duplicate Soil Samples shown in Parts per Million (mg/kg).
ND denotes analyte was not detected at the laboratory detection levels.

7.2 - Geotechnical Analysis and Findings

Geotechnical analysis of selected soil samples was completed to evaluate potential remedial technologies. Samples were selected for geotechnical analysis based on them being representative of the subsurface materials encountered, and at a depth where a remedial technology might be applied. The QA/QC program for geotechnical analysis of the soil samples specified laboratory test procedures which followed ASTM procedures or approved equivalent methods for analysis of textural gradation and percent moisture.

The results of the geotechnical analysis are included as Attachment H for the samples collected from the soil borings, and as Attachment K for the samples collected from the groundwater monitoring well borings, both of which are presented in Volume III of this report. Soil samples collected for geotechnical analysis are listed below:

Geotechnical Samples from Soil Borings

Boring	Depth	Analysis Performed
SB-1	14-16 ft	% Moisture
SB-2	14-16 ft	% Moisture
SB-3	19-21 ft	% Moisture
SB-5	14-16 ft	Textural Gradation, % Moisture
SB-6	19-21 ft	Textural Gradation, % Moisture
SB-10	14-16 ft	Textural Gradation, % Moisture

Geotechnical Samples from Monitoring Well Borings

Well	Depth	Analysis Performed
MWA-4	39-41 ft	Textural Gradation
MWA-5	34-36 ft	Textural Gradation
MWB-2	74-76 ft	Textural Gradation
MWC-1	104-106 ft	Textural Gradation
MWC-2	114-116 ft	Textural Gradation
MWC-3	76-78 ft	Textural Gradation

The laboratory results textural gradation and % moisture are presented in the following tables. Textural gradation was found by sieve analysis with the percent fines (or percent passing the sieve) reported. The % moisture test was conducted using ASTM D-2216.

Boring SB-5 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	100
0.5"	81.8
0.375"	78.7
#4	59.6
#10	40.0
#20	27.9
#40	19.1
#60	13.5
#100	10.7
#140	9.5
#200	8.5

The SB-5 soil sample is described as a brown fine gravelly fine to coarse grained sand.

Boring SB-6 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	92.6
0.5"	87.5
0.375"	81.5
#4	63.0
#10	42.9
#20	28.7
#40	17.1
#60	12.3
#100	9.9
#140	8.9
#200	8.0

The SB-6 soil sample is described as a brown fine gravelly fine to coarse grained sand with a trace of silt.

Boring SB-10 Sieve Size	Textural Gradation Percent Finer
2.5"	—
2"	—
1.5"	—
1"	100
0.75"	88.8
0.5"	70.9
0.375"	62.0
#4	45.7
#10	31.1
#20	22.3
#40	15.9
#60	11.6
#100	9.1
#140	8.1
#200	7.4

The SB-10 soil sample is described as a brown sandy fine gravel with a trace of silt.

Well MWA-4 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	100
0.5"	100
0.375"	100
#4	97.3
#10	93.5
#20	82.0
#40	41.9
#60	13.1
#100	5.6
#140	4.2
#200	3.3

The MWA-4 soil sample is described as dark brown fine to medium sand with a trace of silt & fine gravel.

Well MWA-5 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	100
0.5"	89.0
0.375"	84.3
#4	75.3
#10	60.6
#20	40.0
#40	21.8
#60	11.5
#100	6.7
#140	5.4
#200	4.6

The MWA-5 soil sample is described as dark brown fine to medium sand with fine gravel & a trace of silt.

Well MWB-2 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	92.0
0.5"	83.2
0.375"	81.8
#4	74.0
#10	59.0
#20	39.7
#40	24.1
#60	16.4
#100	11.6
#140	9.8
#200	8.5

The MWB-2 soil sample is described as gray gravelly fine to coarse sand with a trace of silt.

Well MWC-1 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	86.6
0.75"	77.3
0.5"	70.6
0.375"	58.9
#4	41.1
#10	24.2
#20	13.7
#40	7.6
#60	4.7
#100	3.5
#140	2.8
#200	2.3

The MWC-1 soil sample is described as gray sandy fine to coarse grained gravel with a trace of silt.

Well MWC-2 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	100
0.5"	96.5
0.375"	96.5
#4	92.4
#10	83.1
#20	56.1
#40	20.3
#60	8.6
#100	6.1
#140	5.5
#200	5.2

The MWC-2 soil sample is described as gray fine to medium sand with a trace of silt & fine gravel.

Well MWC-3 Sieve Size	Textural Gradation Percent Finer
2.5"	100
2"	100
1.5"	100
1"	100
0.75"	100
0.5"	97.9
0.375"	95.3
#4	89.7
#10	80.6
#20	64.8
#40	41.1
#60	25.1
#100	18.4
#140	15.8
#200	13.5

The MWC-3 soil sample is described as dark brown fine to medium sand with a little silt & fine gravel.

The % moisture content analysis results are presented in the following table. Note that all soil samples were collected above the water table.

Geotechnical Analysis for % Moisture

Boring	Depth	% Moisture
SB-1	14-16 ft	3.7 %
SB-2	14-16 ft	6.2 %
SB-3	19-21 ft	4.3 %
SB-5	14-16 ft	4.9 %
SB-6	19-21 ft	4.7 %
SB-10	14-16 ft	4.5 %

Section 8.0 - Findings and Discussion for Groundwater Samples

Groundwater samples were collected from each of the fifteen groundwater monitoring wells during two sampling events. The wells were sampled twice to determine if there were any effects on water quality due to seasonal water level fluctuations. The first sampling event was completed in December, 1994, and the second was completed in February, 1995. Both groundwater sampling events were performed using EPA approved standard sampling procedures.

Groundwater samples were collected and analyzed for TCL VOCs, and TAL metals. Each well had remained static for approximately two weeks following well development prior to collection of the first round of samples. All wells were screened for evidence of organic vapors prior to collection of the first round of groundwater samples in December 1994 using a PID. The PID was inserted into each open well top immediately upon opening the well. The maximum instantaneous PID measurements were recorded in the field logbook as measured immediately upon opening the well top.

No significantly elevated levels of volatile organic compounds were detected using the PID, and none were measured in excess of levels of concern as described in the health and safety plan. The PID levels in the open wells were immediately reduced to ambient background level as each well vented following opening. The wells were not screened for evidence of volatile organic compounds at the time of the second round of groundwater samples in February 1995 because the ambient air temperature was so low as to render PID measurements unreliable, and the first round PID measurements did not encounter any significantly elevated levels of volatile organic compounds.

Water levels were measured from the top of the PVC casing prior to well purging. An interface probe was used to measure water levels and the thickness of any non-aqueous phase product (LNAPLs or DNAPLs) prior to purging the well in preparation for groundwater sampling. The water levels and notes regarding the possible presence of

non-aqueous phase product were recorded for both sampling rounds. No evidence of LNAPLs or DNAPLs was found during either of the two groundwater sampling rounds, or during collection of additional water level measurements in January 1995. The results of the laboratory analysis for VOCs and metals are presented with a discussion of those findings.

The QA/QC program for chemical analysis of the groundwater samples consisted of the collection and analysis of duplicate samples, spiked samples, equipment blanks and trip blanks. The purpose of this program was to ensure the analyses performed by the analytical laboratory are reproducible. The chain of custody documentation, any QA/QC sample analytical results and the laboratory results for the groundwater samples are included as Attachment M (First Round) and Attachment N (Second Round), both of which are presented in Volume III of this report.

The findings of the laboratory analysis of both rounds of the groundwater samples are presented separately for the VOCs and metals. The water level measurements are presented with an interpretation of groundwater flow directions for the three sets of water level measurements collected.

The contaminant distribution patterns as seen in the groundwater samples are discussed for all the findings including both rounds of groundwater samples and all water level measurements. The information presented for the MWA and MWB wells is applicable to the unconfined aquifer.

8.1 - VOCs Analysis and Findings

First Round Groundwater Samples

The laboratory analysis detected several volatile organic compounds in the first round groundwater samples. The samples containing these detected compounds are listed in the following tables.

VOCs in First Round Groundwater Samples

VOCs	MWA-1	MWA-2	MWA-3	MWA-4	MWA-5	MWA-6
tetrachloroethylene	2500	2400	2200	15	240	1.9
trichloroethene	350	110	240	76000	1100	2600
benzene	ND	ND	ND	ND	ND	ND
1,2-dichloroethene (total)	110	8.3	160	30000	61	74
cis-1,2 dichloroethylene	110	8.3	160	30000	59	73
trans-1,2 dichloroethylene	ND	ND	4.3	110	2.1	1.3
1,1,1-trichloroethane	3300	8600	5500	28	2600	640
1,1,2-trichloroethane	ND	ND	ND	ND	2.1	ND
chloroform	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	65	3.6	590	ND	74	ND
1,2 -dichloroethane	ND	ND	5	ND	5	ND
1,1-dichloroethene	81	84	240	42	260	19
trichlorofluoromethane	ND	ND	ND	ND	2.1	ND
dichlorodifluoromethane	470	94	79	ND	1.5	ND
vinyl chloride	ND	ND	1.7	1100	ND	ND
chloroethane	ND	ND	1.3	ND	ND	ND

VOCs in Round #1 Groundwater Samples. All Results in Parts per Billion (ug/l).
 ND denotes analyte was not detected at the laboratory detection levels.

VOCs in First Round Groundwater Samples

VOCs	MWB-1	MWB-2	MWB-3	MWB-4	MWB-5	MWB-6
tetrachloroethylene	ND	1.6	ND	ND	ND	1.8
trichloroethene	ND	ND	9900	8.7	1	2400
benzene	ND	ND	2.4	ND	ND	ND
1,2-dichloroethene (total)	ND	ND	1700	ND	ND	310
cis-1,2 dichloroethylene	ND	ND	1700	ND	ND	290
trans-1,2 dichloroethylene	ND	ND	24	ND	ND	17
1,1,1-trichloroethane	ND	ND	320	ND	ND	81
1,1,2-trichloroethane	ND	ND	2.5	ND	ND	ND
chloroform	ND	ND	1.9	ND	ND	ND
1,1-dichloroethane	ND	ND	14	ND	ND	85
1,2 -dichloroethane	ND	ND	11	ND	ND	ND
1,1-dichloroethene	ND	ND	27	ND	ND	32
trichlorofluoromethane	ND	ND	3.8	ND	ND	ND
dichlorodifluoromethane	ND	ND	ND	ND	ND	34
vinyl chloride	ND	ND	21	ND	ND	46
chloroethane	ND	ND	ND	ND	ND	ND

VOCs in Round #1 Groundwater Samples. All Results in Parts per Billion (ug/l).
 ND denotes analyte was not detected at the laboratory detection levels.

No volatile organic compounds were detected in the first round of groundwater samples collected from MWC-1, MWC-2, or MWC-3.

Second Round Groundwater Samples

The laboratory analysis detected several volatile organic compounds in the second round groundwater samples. The samples containing these detected compounds are listed in the following tables.

VOCs in Second Round Groundwater Samples

VOCs	MWA-1	MWA-2	MWA-3	MWA-4	MWA-5	MWA-6
tetrachloroethylene	2200	1500	1200	11	140	7.3
trichloroethene	180	250	130	37000	1500	1400
1,2-dichlorobenzene	ND	1.8	ND	ND	ND	ND
1,1-dichloropropene	ND	ND	2.2	ND	ND	ND
1,2-dichloroethene (total)	110	8.9	140	16000	190	110
cis-1,2 dichloroethylene	110	8.5	120	16000	190	110
trans-1,2 dichloroethylene	1.3	3.6	17	75	3.3	3.1
1,1,1-trichloroethane	2000	3800	2300	48	3600	420
1,1,2-trichloroethane	ND	ND	ND	1.8	2.6	ND
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	1.4	ND
chloroform	ND	5	2.2	1.2	2	ND
1,1-dichloroethane	69	3.6	710	12	93	4.3
1,2-dichloroethane	ND	ND	9.4	ND	7.5	ND
1,1-dichloroethene	100	270	100	37	390	34
dichlorodifluoromethane	70	42	17	ND	ND	ND
vinyl chloride	ND	77	53	1400	ND	ND
chloromethane	ND	ND	2.6	ND	ND	ND
chloroethane	ND	ND	2.6	ND	ND	ND

VOCs in Round #2 Groundwater Samples. All Results in Parts per Billion (ug/l).
ND denotes analyte was not detected at the laboratory detection levels.

VOCs in Second Round Groundwater Samples

VOCs	MWB-1	MWB-2	MWB-3	MWB-4	MWB-5	MWB-6
tetrachloroethylene	ND	ND	ND	5.6	ND	1.2
trichloroethene	ND	ND	1100	6.8	ND	760
benzene	ND	ND	2.1	ND	ND	ND
1,2-dichloroethene (total)	ND	ND	3500	1.7	ND	230
cis-1,2 dichloroethylene	ND	ND	3500	1.7	ND	210
trans-1,2 dichloroethylene	ND	ND	28	ND	ND	14
1,1,1-trichloroethane	ND	ND	350	1.3	ND	84
1,1,2-trichloroethane	ND	ND	3.9	ND	ND	ND
chloroform	ND	ND	4.8	ND	ND	ND
1,1-dichloroethane	ND	ND	28	ND	ND	130
1,2 -dichloroethane	ND	ND	42	ND	ND	1
1,1-dichloroethene	ND	ND	28	ND	ND	27
trichlorofluoromethane	ND	ND	ND	ND	ND	ND
dichlorodifluoromethane	ND	ND	ND	ND	ND	4.2
vinyl chloride	ND	ND	26	ND	ND	130
chloromethane	ND	ND	ND	ND	ND	14

VOCs in Round #2 Groundwater Samples. All Results in Parts per Billion (ug/l).
 ND denotes analyte was not detected at the laboratory detection levels.

No volatile organic compounds were detected in the second round of groundwater samples collected from MWC-1, MWC-2, or MWC-3.

Findings

Three isoconcentration contour maps were generated which show the interpreted distribution of volatile organic compounds in groundwater within the unconfined aquifer. Maps were prepared showing: total VOCs (sum of the detected compounds in each well), tetrachloroethylene, and trichloroethene. These maps are included as Drawings 16, 17, and 18 for the first round results, and as Drawings 19, 20, and 21 for the second round results. All Drawings are presented in Volume II of this report.

No VOCs were detected in any of the three deeper wells during analysis of the first round or the second round groundwater samples. Recognizable areas of the site having a particular pattern of VOC contamination in the vadose zone (Area A, B, C) were presented as a working model. This model continues to be useful in the discussion of

contamination patterns, and identification of potential contamination sources. Refer to Figure 3 (see Volume II of this report) for a map of the facility showing these areas.

Total VOCs - Drawing 16 (First Round) and Drawing 19 (Second Round)

The isoconcentration map for total VOCs was contoured using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb, 5,000 ppb, 10,000 ppb, 50,000 ppb, and 100,000 ppb contours. The two isoconcentration maps show only minor variations in the contaminant distribution patterns between the two sampling rounds. The isoconcentration map shows elevated levels of total VOCs were detected in the groundwater within the unconfined aquifer in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B; in the paved area immediately north and east of those buildings; in the southern portion of Building 50, and in the area of the former TCA tank south of Building 53;
- Area B: to the north of Building 59; in the area near Building 47 extending northward and toward the west; and in the area north of the boiler house;
- Area C: along the southern portion of the site adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40A and 40B.

Tetrachloroethylene - Drawing 17 (First Round) and Drawing 20 (Second Round)

The isoconcentration map for tetrachloroethylene was contoured using 50 ppb, 100 ppb, 500 ppb, and 1,000 ppb contours. The two isoconcentration maps show only minor variations in the contaminant distribution patterns between the two sampling rounds. The isoconcentration map shows elevated levels of tetrachloroethylene were detected in the groundwater within the unconfined aquifer in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B; in the paved area immediately north of those buildings; in the southern portion of Building 50, and in the area of the former TCA tank south of Building 53;

- Area B: to the north of Building 59; in the area near Building 47 extending toward the west; and in the area north and west of the boiler house.

Trichloroethene - Drawing 18 (First Round) and Drawing 21 (Second Round)

The isoconcentration map for trichloroethene was contoured using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb, 5,000 ppb, 10,000 ppb and 50,000 ppb contours. The two isoconcentration maps show only minor variations in the contaminant distribution patterns between the two sampling rounds. The isoconcentration map shows elevated levels of trichloroethene were detected in the groundwater within the unconfined aquifer in the following areas:

- Area A: within the northern portion of Buildings 40A and 40B and in the paved area immediately north of those buildings; this contaminant was found in the area of the former TCA tank south of Building 53 but at reduced levels;
- Area B: in the area to the north of Building 59 and west of Building 47 with contamination noted across a broad area of the site but to a lesser degree than seen in Area A or Area C;
- Area C: significantly elevated levels of this contaminant were noted along the southern portion of the site adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40A and 40B.

8.2 - Metals Analysis and Findings

First Round Groundwater Samples

Dissolved metals analysis was performed using field filtered groundwater samples. Eighteen metals were targeted in TAL metals analysis of the groundwater samples. The laboratory analysis detected the following metals in the groundwater samples. The first round groundwater samples containing these detected metals are listed in the following tables.

Metals in First Round Groundwater Samples

Metals	MWA-1	MWA-2	MWA-3	MWA-4	MWA-5	MWA-6
Barium (ug/l)	210	160	250	320	290	150
Calcium (mg/l)	130	100	150	150	140	140
Cobalt (ug/l)	ND	ND	ND	ND	ND	61
Silver (ug/l)	45	34	38	ND	50	ND
Sodium (mg/l)	73	72	96	85	100	81
Vanadium (ug/l)	ND	ND	ND	29	ND	ND
Antimony (ug/l)	6.6	5	4.5	ND	4.9	4.3
Thallium (ug/l)	13	15	21	17	11	8.4

Dissolved Metals in Round #1 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

Metals in First Round Groundwater Samples

Metals	MWB-1	MWB-2	MWB-3	MWB-4	MWB-5	MWB-6
Barium (ug/l)	110	190	110	180	150	180
Calcium (mg/l)	150	160	170	100	150	140
Chromium (ug/l)	ND	ND	ND	ND	23	ND
Cobalt (ug/l)	ND	ND	ND	43	ND	ND
Silver (ug/l)	ND	ND	ND	33	36	45
Sodium (mg/l)	56	180	120	78	150	53
Vanadium (ug/l)	ND	36	42	30	41	ND
Zinc (ug/l)	ND	20	ND	ND	ND	ND
Antimony (ug/l)	ND	5.2	5.1	3	4.7	5.9
Arsenic (ug/l)	2.4	ND	ND	ND	ND	ND
Lead (ug/l)	ND	1.1	1.4	ND	1.1	ND
Thallium (ug/l)	13	42	23	15	26	4.7
Mercury (ug/l)	0.28	ND	ND	ND	ND	ND

Dissolved Metals in Round #1 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

Metals in First Round Groundwater Samples

Metals	MWC-1	MWC-2	MWC-3
Barium (ug/l)	210	220	130
Calcium (mg/l)	100	97	130
Chromium (ug/l)	23	23	ND
Silver (ug/l)	47	44	ND
Sodium (mg/l)	21	32	57
Vanadium (ug/l)	ND	75	31
Antimony (ug/l)	ND	5.7	5.9
Arsenic (ug/l)	7.5	6.9	ND
Lead (ug/l)	ND	ND	1
Thallium (ug/l)	4.8	5.7	11
Mercury (ug/l)	ND	0.58	ND

Dissolved Metals in Round #1 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

The concentrations of the detected metal species were similar when comparing the groundwater samples collected from the unconfined and the semi-confined aquifers. Naturally occurring calcium concentrations were examined by Walton and Scudder, 1960 in glacial aquifers like those found at the subject site. The calcium concentrations reported by Walton and Scudder were in the range of 104 to 144 ppm. The calcium concentrations in the first round groundwater samples were comparable to the published values.

Second Round Groundwater Samples

Dissolved metals analysis was performed using field filtered groundwater samples. Eighteen metals were targeted in TAL metals analysis of the groundwater samples. The laboratory analysis detected the following metals in the groundwater samples. The results were reported by the laboratory in units of mg/l (parts per million), but were converted to the units as reported in the first round results for ease of comparison between the two sample rounds. The second round groundwater samples containing these detected metals are listed in the following tables.

Metals in Second Round Groundwater Samples

Metals	MWA-1	MWA-2	MWA-3	MWA-4	MWA-5	MWA-6
Barium (ug/l)	200	200	240	220	320	200
Calcium (mg/l)	110	110	140	130	120	140
Sodium (mg/l)	59	63	80	83	120	68
Vanadium ug/l)	ND	ND	20	ND	ND	ND
Thallium (ug/l)	11	9	14	12	21	14
Mercury (ug/l)	ND	ND	ND	0.22	ND	ND

Dissolved Metals in Round #2 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

Metals in Second Round Groundwater Samples

Metals	MWB-1	MWB-2	MWB-3	MWB-4	MWB-5	MWB-6
Aluminum (ug/l)	ND	150	ND	ND	180	ND
Barium (ug/l)	100	160	110	180	140	160
Calcium (mg/l)	110	130	150	96	140	130
Cobalt (ug/l)	34	32	ND	ND	29	20
Silver (ug/l)	ND	37	ND	ND	36	ND
Sodium (mg/l)	40	140	100	59	130	80
Antimony (ug/l)	4.4	ND	ND	ND	ND	ND
Arsenic (ug/l)	2.6	ND	ND	ND	ND	ND
Thallium (ug/l)	11	29	15	13	25	10

Dissolved Metals in Round #2 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

Metals in Second Round Groundwater Samples

Metals	MWC-1	MWC-2	MWC-3
Aluminum (ug/l)	140	ND	ND
Barium (ug/l)	210	250	140
Calcium (mg/l)	44	84	120
Cobalt (ug/l)	33	30	ND
Silver (ug/l)	46	40	ND
Sodium (mg/l)	7.9	20	43
Antimony (ug/l)	5.6	4.3	ND
Arsenic (ug/l)	10	6.3	ND
Thallium (ug/l)	4.5	5.4	7

Dissolved Metals in Round #2 Groundwater Samples.

All Results Units as Indicated.

ND denotes analyte was not detected at the laboratory detection levels.

As had been seen in the laboratory results from the first round groundwater samples, the concentrations of the detected metal species were similar in the second round groundwater samples when comparing the groundwater samples collected from the unconfined and the semi-confined aquifers.

QA/QC for First Round Groundwater Samples

The QA/QC program for chemical analysis of the groundwater samples consisted of the collection and analysis of duplicate samples, spiked samples, and equipment and trip blanks. Duplicate samples were collected and analyzed for metals and VOCs as was done

for all the groundwater samples. Sample 94-2-MWC3-12 is a duplicate sample of 94-1-MWC3-12 for VOC analysis. Sample 94-2-MWA5-12 is a duplicate of 94-1-MWA5-12 for metals analysis. Samples were spiked in the laboratory, analyzed and the results were retained at the laboratory in their records retention system.

One equipment blank was collected by pouring deionized water over the decontaminated sampling equipment and collecting the rinsate for laboratory analysis. The rinsate water sample was identified as 94-3-RINS-12. No VOCs were detected in the equipment blank indicating no cross contamination of the samples took place associated with equipment decontamination procedures. One trip blank, identified as 94-4-TB-12, accompanied the samples during transit from the site to the laboratory. No VOCs were detected in the trip blank sample indicating cross-contamination did not take place during sample handling.

The detected VOCs and targeted metals in the duplicate sample pairs are presented in the following table. Overall reproducibility of the laboratory results between the duplicate samples showed that sample handling does not appear to have introduced any significant variability in the results.

Duplicate First Round Groundwater Sample Pairs

Duplicate Samples	94-1-MWC3-12 (Sample)	94-2-MWC3-12 (Duplicate)	% Difference	94-1-MWA5-12 (Sample)	94-2-MWA5-12 (Duplicate)	% Difference
All Targeted VOCs Not Detected	ND	ND	0	—	—	—
Aluminum	—	—	—	ND	ND	0
Barium	—	—	—	290	310	6
Beryllium	—	—	—	ND	ND	0
Cadmium	—	—	—	ND	ND	0
Calcium	—	—	—	140000	140000	0
Chromium	—	—	—	ND	ND	0
Cobalt	—	—	—	ND	ND	0
Silver	—	—	—	50	34	32
Copper	—	—	—	ND	ND	0
Sodium	—	—	—	100000	110000	9
Vanadium	—	—	—	ND	49	>100
Zinc	—	—	—	ND	ND	0
Antimony	—	—	—	4.9	3.3	33

Duplicate Samples	94-1- MWC3-12 (Sample)	94-2- MWC3-12 (Duplicate)	% Difference	94-1- MWA5-12 (Sample)	94-2- MWA5-12 (Duplicate)	% Difference
Arsenic	---	---	---	ND	ND	0
Lead	---	---	---	ND	ND	0
Selenium	---	---	---	ND	ND	0
Thallium	---	---	---	11	13	15
Mercury	---	---	---	ND	ND	0

VOCs and Metals in Round #1 Duplicate Groundwater Samples,
Results shown in Parts per Billion (ug/l).
ND denotes analyte was not detected at the laboratory detection levels.

QA/QC for Second Round Groundwater Samples

The QA/QC program for chemical analysis of the groundwater samples consisted of the collection and analysis of duplicate samples, spiked samples, and equipment and trip blanks. Duplicate samples were collected and analyzed for metals and VOCs as was done for all the groundwater samples. Sample 95-2-MWB3-2 is a duplicate sample of 95-1-MWB3-2 for VOC analysis. Sample 95-2-MWB2-2 is a duplicate of 95-1-MWB2-2 for metals analysis. Samples were spiked in the laboratory, analyzed and the results were retained at the laboratory in their records retention system.

One equipment blank was collected by pouring deionized water over the decontaminated sampling equipment and collecting the rinsate for laboratory analysis. The rinsate water sample was identified as 95-4-EB-2. One VOC compound was detected in the equipment blank. Trichloroethene was detected at 1.2 ug/l (parts per billion). The low level of this compound as detected indicates significant cross-contamination of the samples did not take place due to equipment decontamination procedures.

One trip blank, identified as 95-4-TB-2, accompanied the samples during transit from the site to the laboratory. No VOCs were detected in the trip blank sample indicating cross-contamination did not take place during sample handling.

Overall reproducibility of the laboratory results between the duplicate samples showed that sample handling does not appear to have introduced any significant variability in the

results. The detected VOCs and targeted metals in the duplicate sample pairs are presented in the following table.

Duplicate Second Round Groundwater Sample Pairs

Duplicate Samples	95-1- MWB3-2 (Sample)	95-2- MWB3-2 (Duplicate)	% Difference	95-1- MWB2-2 (Sample)	95-2- MWB2-2 (Duplicate)	% Difference
benzene	2.1	2.4	12	—	—	—
chloroform	4.8	8.1	41	—	—	—
1,1-dichloroethane	28	49	43	—	—	—
1,2-dichloroethane	42	39	7	—	—	—
1,1-dichloroethene	28	61	54	—	—	—
cis-1,2 dichloroethylene	3500	1500	57	—	—	—
trans-1,2 dichloroethylene	28	48	42	—	—	—
1,2-dichloroethene (total)	3500	1500	57	—	—	—
1,1,1-trichloroethane	350	230	34	—	—	—
1,1,2-trichloroethane	3.9	5.1	24	—	—	—
trichloroethene	1100	5700	81	—	—	—
trichlorotrifluoromethane	ND	2.9	>100	—	—	—
vinyl chloride	26	110	76	—	—	—
Aluminum	—	—	—	150	210	29
Barium	—	—	—	160	160	0
Beryllium	—	—	—	ND	ND	0
Cadmium	—	—	—	ND	ND	0
Calcium	—	—	—	130000	140000	7
Chromium	—	—	—	ND	ND	0
Cobalt	—	—	—	32	29	9
Silver	—	—	—	37	36	3
Copper	—	—	—	ND	ND	0
Sodium	—	—	—	140000	150000	7
Vanadium	—	—	—	ND	ND	0
Zinc	—	—	—	ND	ND	0
Antimony	—	—	—	ND	ND	0
Arsenic	—	—	—	ND	ND	0
Lead	—	—	—	ND	ND	0
Selenium	—	—	—	ND	ND	0
Thallium	—	—	—	29	27	7
Mercury	—	—	—	ND	ND	0

VOCs and Metals in Round #2 Duplicate Groundwater Samples,

Results shown in Parts per Billion (ug/l).

ND denotes analyte was not detected at the laboratory detection levels.

8.3 - Water Levels and Groundwater Flow

Water level measurements were collected at each groundwater monitoring well on a monthly basis for a period of three months after completion of the wells. Measurements were obtained prior to the beginning of purging and groundwater sample collection at the time of the first groundwater sampling event on December 13-14, 1994, on January 24, 1995, and at the time of the second groundwater sampling event on February 20, 1995.

Three rounds of water level measurements were collected to observe temporal variations in groundwater levels during the reporting period. The depth to water in each monitoring well was measured and referenced to a standard elevation above mean sea level, thereby allowing computation of the reference elevation for the water level in each well.

First Round Water Level Measurements

Water level measurements collected at the time of the first round groundwater sampling event on December 13-14, 1994 as presented in the following table. No LNAPLs or DNAPLs were detected in any well during the water level measurements.

First Round Water Level Measurements

Well	Depth to Water (Feet)	Well Top Elevation (Feet Above Mean Sea Level)	Water Elevation (Feet Above Mean Sea Level)
MWA-1	27.25	751.43	724.18
MWA-2	25.07	749.45	724.38
MWA-3	27.79	752.19	724.40
MWA-4	26.63	751.27	724.64
MWA-5	26.99	751.25	724.26
MWA-6	27.40	751.75	724.35
MWB-1	20.68	744.93	724.25
MWB-2	27.69	751.62	723.93
MWB-3	27.59	752.13	724.54
MWB-4	28.01	751.64	723.63
MWB-5	26.04	750.73	724.69

Well	Depth to Water (Feet)	Well Top Elevation (Feet Above Mean Sea Level)	Water Elevation (Feet Above Mean Sea Level)
MWB-6	26.87	751.37	724.50
MWC-1	25.53	745.00	719.47
MWC-2	31.47	751.60	720.13
MWC-3	27.66	752.15	724.49

The interpreted direction of groundwater flow was computed for the unconfined aquifer and is shown in Drawing 22. Wells MWA and MWB are completed in the unconfined aquifer. The water elevations were contoured to show lines of equal groundwater elevation above mean sea level. The map shows a generally non-uniform groundwater elevation change, producing a variable gradient, across the site from the southwest toward the northeast. The gradient near the southwestern portion of the site was approximately 0.0003 foot/foot. As can be seen on the map, the gradient becomes steeper in the northeastern portion of the site. There the gradient was approximately 0.001 foot/foot. The interpreted direction of groundwater flow in the unconfined aquifer across the subject site was toward the northeast.

Water level measurements at the MWC-3 well (completed in the semi-confined aquifer below a till layer encountered at approximately 57 feet) and the MWB-3 well installed immediately adjacent to it (completed in the lower portion of the unconfined aquifer) showed only 0.05 foot difference in water elevation. The water levels in the other two semi-confined aquifer wells, MWC-1 and MWC-2, were approximately 4 to 5 feet lower than the water elevation in the unconfined aquifer wells.

Second Round Water Level Measurements

Water level measurements collected January 24, 1995 are presented in the following table. No LNAPLs or DNAPLs were detected in any well during the water level measurements.

Second Round Water Level Measurements

Well	Depth to Water (Feet)	Well Top Elevation (Feet Above Mean Sea Level)	Water Elevation (Feet Above Mean Sea Level)
MWA-1	28.21	751.43	723.22
MWA-2	26.01	749.45	723.44
MWA-3	28.72	752.19	723.47
MWA-4	27.52	751.27	723.75
MWA-5	27.92	751.25	723.33
MWA-6	28.23	751.75	723.52
MWB-1	21.74	744.93	723.19
MWB-2	28.60	751.62	723.02
MWB-3	28.41	752.13	723.72
MWB-4	28.95	751.64	722.69
MWB-5	26.93	750.73	723.80
MWB-6	27.81	751.37	723.56
MWC-1	25.81	745.00	719.19
MWC-2	31.57	751.60	720.03
MWC-3	28.48	752.15	723.67

The interpreted direction of groundwater flow was computed for the unconfined aquifer and is shown in Drawing 23. All water elevations fell approximately 0.5 to 1.0 foot in the unconfined aquifer from the December 1994 levels. The map shows a generally non-uniform groundwater elevation change, producing a variable gradient, across the site from the southwest toward the northeast. The gradient near the southwestern portion of the site was approximately 0.0003 foot/foot. The gradient became steeper in the northeastern portion of the site where it was approximately 0.001 foot/foot. The interpreted direction of groundwater flow in the unconfined aquifer across the subject site remained toward the northeast.

The water level measurements at the MWC-3 well and the MWB-3 well installed immediately adjacent to it again showed only 0.05 foot difference in water elevation. The water levels in the other two semi-confined aquifer wells, MWC-1 and MWC-2, were

approximately 3.5 to 4.5 feet lower than the water elevation of the unconfined aquifer wells, and had fallen approximately 0.1 to 0.5 foot from their December 1994 levels.

Third Round Water Level Measurements

Water level measurements collected at the time of the second round of groundwater sampling on February 20, 1995 as presented in the following table. No LNAPLs or DNAPLs were detected in any well during collection of the water level measurements.

Third Round Water Level Measurements

Well	Depth to Water (Feet)	Well Top Elevation (Feet Above Mean Sea Level)	Water Elevation (Feet Above Mean Sea Level)
MWA-1	28.54	751.43	722.89
MWA-2	26.29	749.45	723.16
MWA-3	29.01	752.19	723.18
MWA-4	27.72	751.27	723.55
MWA-5	28.18	751.25	723.07
MWA-6	28.50	751.75	723.25
MWB-1	22.11	744.93	722.82
MWB-2	28.93	751.62	722.69
MWB-3	28.64	752.13	723.49
MWB-4	29.28	751.64	722.36
MWB-5	27.20	750.73	723.53
MWB-6	28.06	751.37	723.31
MWC-1	26.18	745.00	718.82
MWC-2	31.97	751.60	719.63
MWC-3	28.73	752.15	723.42

The interpreted direction of groundwater flow was computed for the unconfined aquifer and is shown in Drawing 24. All water elevations fell approximately 0.25 to 0.5 foot in the unconfined aquifer from the January 1995 levels. The map shows a generally non-uniform groundwater elevation change, producing a variable gradient, across the site from the southwest toward the northeast. The gradient near the southwestern portion of the

site was approximately 0.0003 foot/foot. The gradient became steeper in the northeastern portion of the site where it was approximately 0.001 foot/foot. The interpreted direction of groundwater flow in the unconfined aquifer across the subject site remained toward the northeast.

The water level measurements at the MWC-3 well and the MWB-3 well showed only 0.07 foot difference in water elevation. The water levels in the other two semi-confined aquifer wells, MWC-1 and MWC-2, were approximately 3.75 to 4.5 feet lower than the water elevation of the unconfined aquifer wells, and had fallen approximately 0.3 to 0.4 foot from their January 1995 levels. The water elevation in the MWC-3 well fell 0.23 foot from the January 1995 level, much like what had occurred at the unconfined aquifer wells.

The technique of generating a graphical solution for establishing groundwater flow direction requires a minimum of three measurement points distributed across the area of interest in order to generate a credible flow direction. Three wells were installed in the semi-confined aquifer, however, the water elevation in the MWC-3 well suggests that well appears more similar to the unconfined aquifer wells, that is, the MWC-3 well appears to be hydraulically connected to the unconfined aquifer. With only two wells yielding water elevations which might be reliably associated with the semi-confined aquifer, its flow direction and gradient cannot be well understood at this time.

8.4 - Discussion of Findings

The groundwater sample results, groundwater flow patterns, and interpreted distribution of contaminants revealed the following patterns of contamination in the unconfined aquifer across the property:

- The levels of tetrachloroethylene in the unconfined aquifer appear to be greatest in the central portion of the facility within Area A and Area B. The distribution of the tetrachloroethylene controls the total VOCs

distribution pattern in that portion of the site, indicating tetrachloroethylene is the principal contaminant in that portion of the site.

- The areas affected by tetrachloroethylene contamination are the northern portion of Buildings 40A and 40B and the paved area immediately north and east of those buildings; the southern portion of Building 50, the area of the former TCA tank south of Building 53; the area to the north of Building 59; the area near Building 47 extending northward and toward the west; and the area north and west of the boiler house;
- The concentrations of trichloroethene in the unconfined aquifer appear to be greatest along the southern portion of the site within Area C. The distribution of the trichloroethene controls the total VOCs distribution pattern in that portion of the site, indicating trichloroethene is the principal contaminant in that portion of the site.
- The areas affected by trichloroethene contamination are adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40A and 40B. Area A and Area B are affected by this contaminant but to a much lesser degree.

These findings agree well with the work completed during previous investigations at the facility, the soil vapor survey and the soil sample analysis completed as a part of this investigation. The areas near Buildings 40A and 40B, the area to the south of Building 53 near the former TCA tanks, the area east of Building 50, and the western and southern portions of the former Maxwell Complex are areas where elevated levels of VOC contamination have been documented in soil and groundwater.

The patterns of contamination by the principal mapped contaminants in the soil and groundwater, tetrachloroethylene and trichloroethene, reveal a contaminant transport relationship between the soil and groundwater. These two compounds account for the overall pattern of VOC contamination observed in the soil and groundwater.

Groundwater contamination plumes appear to originate from locations within the plant, or as plumes entering the site from off-site sources in areas where soil contamination is also present, particularly in the deeper portion of the vadose soil zone. Soil and groundwater contamination by tetrachloroethylene is greatest in Areas A and B. Soil and groundwater contamination by trichloroethene occurs mainly in Area C.

Additional relationships were observed. Several organic compounds having greater concentration levels were detected in the unconfined aquifer in the MWA wells than the MWB wells, that is, contamination is greater in the shallow portion of the unconfined aquifer than the deeper portions of the same aquifer. This pattern suggests groundwater in contact with the base of the unsaturated soil zone is in contact with a contamination source, possibly only during certain periods of time in response to seasonal water level fluctuations.

Contaminants may enter groundwater as they become dissolved into the water from contaminant sources in the unsaturated soil zone. Seasonal water level fluctuations, as observed during this investigation, appear to remove groundwater from contacting contaminated soil. As the water levels fell during the three month period of this investigation, the overall level of groundwater contamination by VOCs decreased. This contaminant migration model is supported by the pattern of greater contamination having been documented in the deep vadose soil and greater groundwater contamination having been documented in the wells completed in the upper portion of the unconfined aquifer.

The three groundwater elevation maps show the groundwater flow direction remained constant during the investigation. The groundwater flow gradient appeared to vary across the site for each set of water level measurements, but the amount of variance in the gradient appeared to remain constant between measurement sets. The groundwater contamination plumes as shown on the isoconcentration maps conform well to the interpreted groundwater flow direction. The contaminant plumes in Areas A and B appear

to originate from locations within the plant. The plume shown in Area C appears to originate either from the portion of the site directly adjacent to Leo Street, or from some off-site source.

The findings for both groundwater sampling rounds show the semi-confined aquifer does not appear to be affected by VOC contamination at this time. No VOCs were detected in any well completed in the semi-confined aquifer in either groundwater sampling round.

The metals concentrations were similar in both the unconfined and semi-confined aquifers. This suggests that since the absence of VOCs in the semi-confined aquifer can be interpreted as an indication of no impact to that aquifer. The similarity of the metals concentrations in the aquifers can be interpreted as evidence of no significant impact to groundwater in either aquifer by the targeted metals at this time.

Section 9.0 - Interpretations of Contaminant Distribution Patterns

Contaminant distribution patterns were established using information generated from several investigative methods. A review of previous limited investigations and existing information sources was conducted. This was followed by a soil vapor survey which established contamination patterns in portions of the site designated as Areas A, B, and C. Soil samples were collected from soil borings and during the installation of the groundwater monitoring wells for TCL VOCs and TAL metals. Two rounds of groundwater samples were collected and analyzed for TCL VOCs and TAL metals. Groundwater flow directions and water level fluctuations were examined for the unconfined aquifer using three sets of water level measurements. This information was compiled as an integrated package and contaminant distribution patterns were developed for soil and groundwater. The affected areas as documented through the different investigative techniques have been related to the reference Areas A, B, and C.

Previous investigations indicated soils and groundwater had been impacted by volatile organic compounds with limited heavy metal contamination documented in the area of the former Maxwell Complex. Aerial photographs showed areas of possible concern within the northern areas of the plant prior to its development, unpaved areas within the plant boundaries which formerly existed near the manufacturing buildings, and an area where easy access to the undeveloped northern portion of the site was possible prior to its development. Additionally, several areas were identified where material storage took place within the plant boundaries over many years, particularly in the area adjacent to Leo Street in the extreme southern area.

Sanborn maps showed areas of possible concern associated with historical manufacturing processes and materials handling areas within the plant boundaries in association with the former Maxwell Complex. Off-site areas of concern were focused along the southern portion of the site including the former paint and varnish facility across Leo Street, the former service stations located across Leo Street and at the intersection of Leo and

Webster Streets, and the group of light industries located approximately 300 to 400 feet south of the DTPP property.

A review of potential contamination sources conducted by Clean Tech revealed several potential on-site sources of contaminants which may have impacted the soil or groundwater. These potential sources include: underground and above ground storage tanks, chemical handling or storage areas, hazardous waste generation and accumulation storage areas, sumps for waste oil or process wastewater, past spills, and various processes or operations of the plant.

Significant potential on-site sources of contamination include tanks which stored TCA and TCA sludge which were located on the south side of Building 53 and the north side of Building 40; a TCE degreaser station formerly located near the southern end of Building 53; a TCA degreaser formerly located in the northeast area of Building 40A; and a CFC-113 degreaser formerly located in the middle of Building 40A. Spill records revealed potential contamination from spills of approximately 500 gallons of chrome-containing paint sludge in Building 47; an overfill of TCA storage tank (quantity unspecified); a release of approximately 35 gallons of untreated wastewater containing flux rinse water near Building 50; and a release of an unspecified quantity of TCA from a tank next to Building 53.

The soil vapor survey revealed contamination in the vadose zone across the property. VOC contamination in the vadose zone appeared to be greatest in Area A in both the shallow and deep portions of the vadose zone. VOC contamination in the vadose zone was noted at a lesser magnitude across Area B in both the shallow and deep portions of the vadose zone, but was much more pronounced in the deep vadose zone. Isolated areas of significantly elevated VOCs were noted in Area C for both the shallow and deep portions of the vadose zone, but were much more pronounced in the deep vadose zone.

Soil sample analysis confirmed these patterns of soil contamination across the property. Tetrachloroethylene in the soil was greatest in the central portion of the facility within Area A and Area B. The distribution of the tetrachloroethylene controls the total VOCs distribution pattern in these areas. Trichloroethene in the soil was greatest along the southern portion of the site within Area C. The distribution of the trichloroethene controls the total VOCs distribution pattern in the southern area.

Groundwater sample analysis and groundwater flow patterns established a contamination pattern which relates vadose soil and groundwater contaminants in the unconfined aquifer across the property. No detectable levels of VOCs were found in the semi-confined aquifer for first round or second round groundwater samples. No LNAPLs or DNAPLs were detected in any well for any of the three sets of water level measurements.

The levels of tetrachloroethylene in the unconfined aquifer were greatest in the central portion of the facility within Area A and Area B in the same area and pattern similar to that seen for the soil contamination. The distribution of the tetrachloroethylene controls the total VOCs distribution pattern in those areas. The levels of trichloroethene in the unconfined aquifer were greatest along the southern portion of the site within Area C in the same area and pattern similar to that seen for the soil contamination. The distribution of the trichloroethene controls the total VOCs distribution pattern in that portion of the site, indicating trichloroethene is the principal contaminant in Area C.

The information gathered through each investigative technique may be summarized as follows for each contamination area:

Area A

- Previous Investigations

Soil contaminants at Building 40B in the area of former CFC-113 degreaser station, and soil and groundwater contaminants on south side of Building 53 in

the area of the former TCA storage tanks, and at Buildings 40A and 40B which contained former TCA degreasers.

- Soil Vapor Survey

Areas with elevated VOCs in the area to the north of Buildings 40A and 40B, and to the south of Buildings 50 and 53 in the area of the former TCA storage tanks with VOCs elevated in both shallow and deep vadose soil zones with greater contamination in the deep vadose zone.

- Soil Samples

Affected areas are northern portions of Buildings 40A and 40B and the paved area immediately north and east of those buildings, and the southern portion of Building 50 in the area of the former TCA tank south of Building 53.

- Groundwater

Areas affected by contamination are the northern portion of Buildings 40A and 40B and the paved area immediately north and east of those buildings, and the southern portion of Building 50 in the area of the former TCA tank south of Building 53.

Area B

- Previous Investigations

Soil and groundwater contaminants noted in the west and southwest sections of the former Maxwell Complex, and in the storage areas located east of Building 50. Well 2, the production well located in the boiler house and completed in the unconfined aquifer, was found to contain organic compounds. Testing suggested a large volume of the aquifer may be affected by the contaminants.

- Soil Vapor Survey

Areas with elevated VOCs in the area to the north of Building 59 to the area of Building 47 and the associated waste storage area with VOCs elevated in both

the shallow and deep vadose zone and greater contamination noted in the deep vadose zone.

- Soil Samples

Affected areas are to the north of Building 59, in the area near Building 47 extending northward and toward the east; and in the area north of the boiler house and northeast of Building 47.

- Groundwater

Areas affected by contamination are the area to the north of Building 59; the area near Building 47 extending northward and toward the west; and the area north and west of the boiler house.

Area C

- Soil Vapor Survey

Isolated areas of elevated VOCs were noted in the southern portion of the site to the west of Building 3A and south of Building 59, and in the area to the south of Buildings 40 and 40A. This pattern was noted for both the shallow and deep portions of the vadose zone, with greater contamination noted in the deep vadose zone.

- Soil Samples

Areas affected by contamination are adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40, 40A and 40B.

- Groundwater

Areas affected by contamination are the area adjacent to Leo Street south of Building 59, Building 3A, and Buildings 40A and 40B.

The patterns of contamination by the principal mapped contaminants in the soil and groundwater, tetrachloroethylene and trichloroethene, suggest a contaminant transport mechanism involving interactions between the soil and groundwater. The patterns of soil

and groundwater contamination may be explained using the available information in the following conceptual model for Areas A and B, and for Area C of the site.

Area A and Area B

The soil contamination as seen across Area A and Area B in the soil vapor and soil sample analysis is typically greater in the deeper portions of the vadose zone soils, with the clear exception of the area of the former TCA tanks where significant vadose zone soil contamination both shallow and deep suggests this is a primary source location of solvent contamination to the soils. Other possible secondary contaminant source areas include the area to the east of Building 50 and the waste storage area near Building 47 north of Building 59. Previous studies and the pattern of contamination found in this investigation identified the subsurface beneath Buildings 40A and 40B as potential contaminant source areas.

Solvents containing chlorinated organic compounds are interpreted to have entered the subsurface environment at these source locations. After soil contaminants penetrated to a depth near the base of the vadose zone, groundwater in the unconfined aquifer was brought in contact with the contaminated soil allowing contaminants to be released into the groundwater. Groundwater flow in the unconfined aquifer moved the groundwater toward the northeast under the influence of the steepening hydraulic gradient induced by the pumping well at Gem City Chemicals, Inc. The groundwater flowing past the contaminant sources acquired dissolved contaminants and carried the contaminants across the site toward the northeast forming contamination plumes.

The steepening hydraulic gradient which was persistently seen in all water elevation maps is interpreted to represent the influence of the groundwater recovery well system at the Gem City Chemical facility as it draws groundwater toward the pumping well. The recovery well pumps continuously in the unconfined aquifer at approximately 300 gpm. The pumping well was required by the Ohio EPA to prevent introduction of contaminants from Gem City Chemical into the South Miami Well Field. The groundwater elevation

maps show a generally non-uniform groundwater elevation change, producing a variable gradient, across the subject site from the southwest toward the northeast in all three measurement sets. The uniformity of the hydraulic conditions were maintained as water levels fell in the unconfined aquifer, indicating the pumping well exerted primary hydraulic control over the groundwater flow pattern. This interpretation is in agreement with the potentiometric measurements for the Gem City site as reported by QSource Engineering, Inc. QSource Engineering reported that changes in water levels and recharge do not appear to affect the general direction of groundwater flow. QSource Engineering estimated the groundwater flow direction was to the northeast in the portion of the Gem City site adjacent to the DTPP site. This flow direction and the reported configuration of the groundwater potentiometric surface agree closely between the two sites, further demonstrating the interconnection between pumping at Gem City and the behavior of the groundwater across the DTPP property.

As groundwater moved toward the northeast carrying dissolved contaminants from the source locations, the soils in contact with the moving groundwater plumes absorbed some of the contaminants. This formed broad soil contamination plumes and may account for the similarity in location and pattern for both the soil contaminant and groundwater contaminant plumes as mapped. The areas of the greatest soil contamination and greatest groundwater contamination are coincident. Seasonal fluctuations in water levels (reported annual total of 10 to 15 feet) would be expected to exacerbate this situation over time, causing an additional vertical thickness of soil near the base of the vadose zone to be exposed to the dissolved contaminants in the groundwater. Under these conditions, the potential for off-site transport of contaminants is significant over time, first as dissolved groundwater contamination, and secondly as soil contamination near the base of the vadose zone. As shown on the isoconcentration maps, the potential exists at present for some off-site transport of contaminants in groundwater to have occurred.

Additional supporting evidence for this mechanism comes in two forms. First, larger numbers of organic compounds having greater concentration levels are present in the

groundwater samples from the unconfined aquifer in the MWA (shallower) wells than the MWB (deeper) wells. Overall VOC contamination is greater in the shallow portion of the unconfined aquifer in contact with the deep vadose zone than the deeper portions of the same aquifer. Second, seasonal water level fluctuations as observed during this investigation appeared to remove groundwater from contacting the zone of contaminated soil. As the water levels fell during the three month period of this investigation, the level of groundwater contamination by VOCs decreased.

Area C

Groundwater flows to the north onto the site from across Leo Street. The soil and groundwater contamination plume shown in Area C appears to originate from some off-site source, particularly from the area across Leo Street from the site boundary as groundwater flows on the site from adjacent properties. Certain properties in this area have been identified as potential sources of contaminants. The soil contamination as seen across Area C in both the soil vapor survey and the soil sample analysis is typically greater in the deeper portions of the vadose zone soils, and has trichloroethene as the primary compound present. The available information for the soil in the shallow vadose zone provided no clear indication of a source area for chlorinated solvents on the property. The soil vapor survey did not identify significantly elevated levels of VOCs in the shallow vadose zone in Area C. This evidence supports the idea of an off-site source for the contaminants.

A soil sample from SB-10 was collected from below the water table at 31 feet and was found to contain significantly elevated levels of VOCs, particularly trichloroethene, in the saturated soil approximately four feet below the water table. It may be interpreted that this contaminant is flowing on the property from an off-site source to the south. Additional supporting evidence for an off-site contaminant source is the presence of benzene in both rounds of groundwater samples collected from MWB-3 when that compound is not a contaminant of concern at any other location on the site. Benzene is a contaminant typically associated with petroleum and may have entered the subsurface

environment from a leaking storage tank, or possibly from some operation at the former paint and varnish operation located across Leo Street from the site boundary.

A hydraulic connection between the MWC-3 well and the unconfined aquifer apparently occurs because the till layer seen in the southeastern portion of the site becomes substantially thinner and ceases to be a hydraulic barrier in the east central portion of the site. The till layer has apparently protected the portion of the unconfined aquifer below the till layer in the extreme southeastern portion of Area C from encountering significant contamination by organic compounds. The MWB-3 well, completed in the unconfined aquifer above the till layer, was found to have up to 13,727.6 ppb total VOCs in a groundwater sample. Both groundwater samples collected from MWC-3, completed in the unconfined aquifer below the till layer, were found to have less than detectable levels of total VOCs.

Groundwater flowing in the unconfined aquifer moves northward toward the cone of influence developed by the Gem City recovery well. The groundwater within the unconfined aquifer is interpreted to pass this point both above and below the clay layer within the unconfined aquifer. This pattern of groundwater movement apparently prevents contaminants entering the aquifer from the ground surface from impacting the portion of the unconfined aquifer below the clay layer in which MWC-3 is screened. The clay layer is expected to extend intact to the south (on the opposite side of Leo Street) a distance at least as great as the distance to the proposed contamination source.

The findings for both groundwater sampling rounds show the semi-confined aquifer does not appear to be affected by VOC contamination at this time. No VOCs were detected in any well completed in the semi-confined aquifer in either groundwater sampling round. The vertical flow potential provides an assessment of the potential for movement of groundwater, and potential contaminants, from one aquifer to another. The available information as compiled during regional hydrogeological analysis, and for the site specific information generated as a part of this investigation indicate the potential exists for

groundwater to move downward from the unconfined aquifer to the semi-confined aquifer. The confining layer between the aquifers has apparently prevented contamination of the semi-confined aquifer based on the available information.

The metals concentrations in groundwater were similar in both the unconfined and semi-confined aquifers. Since the absence of VOC contamination in the semi-confined aquifer can be interpreted as an indication of no impact to that aquifer, the similarity of the dissolved metals concentrations in the aquifers may be interpreted as evidence of no significant impact to groundwater in either aquifer by the targeted metals at this time. The metals contamination in soils as encountered in the area of the former Maxwell Complex was apparently confined to the soils present in that limited area.

Section 10.0 - Targets for Soil and Groundwater Remediation

The following discussion of targets for soil and groundwater remediation are presented as guidance for development of goals for remediation of soil and groundwater contamination at the Chrysler DTPP facility.

The Ohio EPA Division of Emergency and Remedial Response has developed guidance for site investigations and remediation programs. Ohio EPA evaluates every site independently and will not provide generic clean-up guidance or criteria. The policy was originally developed for unregulated hazardous waste sites but has been extended to the entire Ohio EPA Remedial Response Program.

The selection of soil and groundwater remediation targets typically begins with a determination of the levels of site contamination through a site investigation. A site is considered to be hazardous by the Ohio EPA if a contaminant is present on-site at concentrations significantly above background levels, or the contaminant is present on-site and is not detected in representative background samples. The DTPP facility appears to fall in the hazardous site category based on the findings of this investigation.

Ohio EPA guidance stipulates a determination of whether contamination poses a threat to public health or the environment. Normally this involves preparation of a site-specific health-based risk assessment for most locations within Ohio. Following preparation of the risk assessment, a review of applicable ARARs (applicable or relevant and appropriate standards and/or criteria) is usually undertaken. The selection of remedial alternatives and design goals normally results from these activities. However, an overriding issue in Dayton is the delineation of a portion of Dayton in the area of the DTPP facility as a Well Field Protection Area.

Mr. Joe Smindak of the Ohio EPA was contacted regarding this issue on April 25, 1995. Mr. Smindak indicated that the Well Field Protection Program instituted in Dayton is a nationally recognized program which seeks to monitor the public water supply source aquifer, and has as a future goal the development of a comprehensive Well Field Management Plan. This management plan has not yet been initiated but will be based on the findings of the Ohio EPA groundwater quality monitoring program now underway. The Ohio EPA routinely monitors groundwater using a network of wells installed throughout Dayton in public lands and right-of-ways. Mr. Smindak noted that the management plan is needed primarily because groundwater quality monitoring has shown organic contaminants are commonly dispersed across large areas in the subsurface throughout Dayton. The contaminants are commonly organic solvents which have found their way into the aquifer due to a long history of manufacturing land uses, and the effects of pumping from numerous water supply wells in Dayton. The contaminants are known to enter the aquifer near certain properties, and pass under other properties where they may be detected at monitoring points and in water supply wells. Mr. Smindak stated that at some point in the future a program to address these large areas of contaminants will be brought forward by the Ohio EPA.

The Ohio EPA currently seeks only to prevent significant contamination from reaching the public water supply wells through a program of Interim Action requirements. Interim Actions for groundwater are the only approved remedial actions which may be undertaken within the Well Field Protection Area. Groundwater gradient control is the most commonly required Interim Action. The need for groundwater gradient control is based on what Ohio EPA has defined as Interim Standards. If an Interim Standard for groundwater quality is exceeded at a site, then Ohio EPA seeks to have the property owner control and remediate contaminated groundwater to prohibit it from leaving the effected property. The process of calculating the Interim Standard for a site involves review of the following standards:

- Carcinogenic standards for each detected compound which will produce a frequency of 10^{-6} cancer cases (one cancer case per million population exposed) in the effected population;
- Non-carcinogenic standards for each detected compound which will produce a Hazard Index of 1 for the effected population;
- Maximum Contaminant Levels (MCLs) derived from US EPA drinking water regulations and health advisories.

The lowest value resulting from the review of the three standards listed above becomes the Interim Standard for the detected compound, provided the standard is not less than 1 ppb. In those cases 1 ppb becomes the Interim Standard. Under the Interim Actions process only the groundwater pathway is assessed, and no cumulative or synergistic effects are incorporated into the risk analysis. Achieving protection of the groundwater within the Well Field Protection Area is done by meeting the Interim Standard set for each detected contaminant. If the detected contaminant levels are below the Interim Standards, then there is no requirement to achieve groundwater gradient control and perform any treatment of extracted groundwater.

Interim Standards were applied to the remedial actions which have been undertaken at the DAP, Inc. and the Gem City Chemicals, Inc. facilities. The DAP facility employed a soil vapor extraction system to remove the contaminant source within the soil as a method of preventing groundwater contamination. DAP achieved groundwater gradient control using a system of four groundwater recovery wells plus an air stripping tower to remove a variety of solvents from the groundwater. Routine monitoring of wells at the site demonstrated groundwater quality has improved to within the Interim Standards, and the recovery wells are expected to be shut down in the near future.

Gem City Chemicals, Inc. achieved groundwater gradient control using a groundwater recovery well and an associated air stripper system. A soil vapor extraction system was

also employed to remediate the soil which was contributing contaminants to the groundwater. The soil vapor extraction system was discontinued when no significant concentration of VOCs (≤ 5 ppm) were detected in the exhausted air. Groundwater gradient control and remediation continues on an ongoing basis using a single recovery well.

Interim Standards were computed using the laboratory results for the organic compounds detected in both the first and second round groundwater samples from the subject site. The detected concentrations were averaged for the MWA and MWB wells for each compound detected, using both the first and second round samples. The carcinogenic standard or hazard index was taken from the Risk Based Concentration (RBC) tables prepared by US EPA Region III, as recommended by the Ohio EPA, for each detected compound. The reported RBC value corresponds to a contaminant concentration exposure concentration through a certain pathway which produces a fixed level of risk, either the hazard index of 1 or lifetime cancer risk of 10^{-6} whichever occurs at a lower concentration. The RBC value for water (tap water) as a pathway was used. The MCLs were taken from the November 1994 US EPA Drinking Water Regulations and Health Advisory tables.

Interim Standards for Detected VOCs in Groundwater

VOCs	Averaged Concentration	RBC Value	MCLs	Ohio EPA Interim Standard	Interim Standard Exceeded?
tetrachloroethylene	777	1.1	5	1.1	Yes
trichloroethene	7107	1.6	None	1.6	Yes
benzene	2.3	0.36	5	1.0	Yes
1,2-dichloroethene (total)	3101	55	None	55	Yes
cis-1,2 dichloroethylene	3097	61	70	61	Yes
trans-1,2 dichloroethylene	21.7	120	100	100	No
1,1,1-trichloroethane	1981	1300	200	200	Yes
1,1,2-trichloroethane	2.6	0.19	5	1.0	Yes
chloroform	2.9	0.15	100	1.0	Yes
1,1-dichloroethane	134	810	None	810	No
1,2 -dichloroethane	11.6	0.12	5	1.0	Yes
1,1-dichloroethene	111	0.044	7	1.0	Yes
trichlorofluoromethane	3.0	1300	None	1300	No
dichlorodifluoromethane	90.2	390	None	390	No
vinyl chloride	317	0.019	2	1.0	Yes
1,2-dichlorobenzene	1.8	270	75	75	No
1,1-dichloropropene	2.2	None	None	None	—
1,1,2-trichloroethane	2.2	0.19	5	1.0	Yes
1,1,1,2-tetrachloroethane	1.4	0.41	None	1.0	Yes
chloromethane	8.3	1.4	None	1.4	Yes
chloroethane	2.0	8600	None	8600	No

All Results in Parts per Billion (ug/l).

Fourteen of the twenty-one detected volatile organic compounds exceed the Interim Standards for those compounds. The Interim Standards may be viewed as goals for groundwater remediation at the Chrysler DTPP facility.

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#15

**SITE INVESTIGATION REPORT
CHRYSLER CORPORATION
DAYTON THERMAL PRODUCTS PLANT
1600 WEBSTER STREET
DAYTON, OHIO 45404**

**Volume II of III
Figures, Attachments, Drawings**

Prepared For
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Prepared By
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September, 1995



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September 14, 1995

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Auburn Hills, MI 48326-2757

**RE: Finalized Site Investigation Report
Chrysler Corporation Dayton Thermal Products Plant
Dayton, Ohio**

Dear Mr. Chapman:

Enclosed please find the three volume finalized document Site Investigation, Chrysler Corporation Dayton Thermal Products Plant, Dayton Ohio. This submittal includes your review comments and requested report revisions. Comments received from Mr. Doug Orf are incorporated in this final submittal. This document has been forwarded to Mr. Orf per your request.

If you have any questions, please contact Clean Tech at (302) 999-0924.

Sincerely,

Steven W. Newsom, P.G.
Principal Geologist
CLEAN TECH

Sincerely,

Deborah A. Buniski, P.E.
President
CLEAN TECH



CLEAN **TECH**

September 14, 1995

Mr. Douglas J. Orf
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

**RE: Finalized Site Investigation Report
Chrysler Corporation Dayton Thermal Products Plant
Dayton, Ohio**

Dear Mr. Orf:

Enclosed please find the three volume finalized document Site Investigation, Chrysler Corporation Dayton Thermal Products Plant, Dayton Ohio. This submittal includes comments and requested report revisions as received from you and Mr. Curtis Chapman. This document has been forwarded to Mr. Chapman.

If you have any questions, please contact Clean Tech at (302) 999-0924.

Sincerely,

Steven W. Newsom, P.G.
Principal Geologist
CLEAN TECH

Sincerely,

Deborah A. Buniski, P.E.
President
CLEAN TECH

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Figures, Attachments, Drawings
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FIGURE 1
Site Location Map
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

FIGURE 2
Map of Facility
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

FIGURE 3
Map of Facility Showing Areas A, B, C
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

FIGURE 4
Locations of Geologic Cross-Sections
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404

ATTACHMENT A
Aerial Photograph Series
Chrysler Corporation
Dayton Thermal Products Plant
1600 Webster Street
Dayton, Ohio 45404



Aerial Photograph - 05-24-61

CHRYSLER CORPORATION
DAYTON THERMAL PRODUCTS

Clean Tech Inc. - Newark, Delaware